OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

ERRATA

QA: QA

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DC Tracking No. 36917

2. Product DI:	Title:	Revision:
ANL-MGR-MD-000001	Inhalation Exposure Input Parameters for the Biosphere Model	2

3. Location	4. Clarification/Restriction
1. Section 6.2.4.2 (page 54) and Table 7-1 (page 64). Discussion and presenation of distribution of mass loading for the asleep indoor environment.	1. The upper bound of the distribution should be 0.050 mg/cubic meter, not 0.060 mg/cubic meter.
2. Table 6.2.2-1 (page 50).	2. The source DTN is MO0008SPATSP00.013
3. Page 57. 1st parargaph. 4th line.	3. The appendix reference should be Appendix D.

5. QER Review: (Print Name)	Initials:	Date:
KENNETH O. GILKERSON	KOG	9-24-2003
6. Responsible Manager: (Print Name)	Initials:	Date:
MARYLA A. WASIOLEK	MW	9.24.2003

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SCIENTIFIC ANALYSIS COVER SHEET

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Inhalation Exposure Input Parameters for the Biosphere Model

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6. Originator	Kurt R. Rautenstrauch	SIGNATURE ON FILE	6/10/03
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11. Remarks

Technical Contact/Department: Kurt Rautenstrauch/Environmental, Safety, and Health

Revision History

12. Revision/ICN No.	13. Description of Revision/Change
REV 0	Initial Issue
REV 0 / ICN 1	Changed verification status of climate data (Table 1 and DIRS); added data tracking numbers for data accepted since release of REV 00(Table 1; pp. 1, 9, 10, 17, 20, 21; DIRS); used modified crop coefficients for turf grass.
REV 1	Added parameter values for analysis of volcanic eruption and climate change (throughout). Revised inputs and parameter values for mass loading to reflect a farming community and to base values on total suspended
REV 2	Entire report revised. Reanalyzed all mass loading parameter distributions for use in biosphere model to be used in support of License Application. Added mass loading time function and associated decrease constant

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CONTINUATION PAGE

Revision History	
12. Revision/ICN NO.	13. Description of Revision/Change
REV 0 / ICN 1	which resulted in different values for irrigation rate (Tables 1, 3, 4 and pp. 10, 20); modified justification for selecting climate and air quality data from site 9 (pp. 7, 9); replaced reference to unfinished AMR with reference to Census Bureau data (pp. 6, 9, 11, 12, 16); and used electronic DIRS.
REV 1	particles (Sections 4.1.1, 5.1.1, and 6.1.1). Added key technical issues and acceptance criteria (Section 4.2). Revised assumptions for time spent outdoors (Section 5.2.3) and parameter values for inhalation exposure time (Section 6.2) and external exposure time (Section 6.4). Corrected average annual precipitation value used in calculation of home irrigation rate (Section 6.5 and Appendix B). Updated format throughout.
REV 2	parameter. Removed parameters for chronic breathing rate, exposure times, home irrigation rate, and duration of home irrigation. Changed title.

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FIGURES

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ACRONYMS

BDCF	Biosphere Dose Conversion Factor
DOE	U.S. Department of Energy
DTN	Data Tracking Number
EPA	U.S. Environmental Protection Agency
ERMYN	Environmental Radiation Model for Yucca Mountain, Nevada
FEPs	Features, Events, and Processes
$PM_{2.5}$	Particles with an aerodynamic diameter ≤2.5 μm
PM_4	Particles with an aerodynamic diameter ≤4 μm
PM_{10}	Particles with an aerodynamic diameter ≤10 μm
sd	Standard Deviation
TSP	Total Suspended Particles
TSPA	Total System Performance Assessment

VARIABLES

BR_n	Breathing rate in environment *n*
$BDCF_i(d_a,t)$	BDCF of radionuclide *i* for an ash deposition depth d_a at time *t* following a volcanic eruption
$BDCF_i$	BDCF of radionuclide *i* for external exposure, radon inhalation, and ingestion following a volcanic eruption
$BDCF_{inh,p,i}$	BDCF of radionuclide *i* for inhalation of resuspended particles at nominal concentrations of mass loading following a volcanic eruption
$BDCF_{inh,v,i}$	BDCF of radionuclide *i* for inhalation of resuspended particles at concentrations greater than nominal concentrations following a volcanic eruption
$Ca_{h,i,n}$	Activity concentration of radionuclide *i* in air from soil resuspension
$Cs_{m,i,}$	Activity concentration of radionuclide *i* in the surface soil per unit mass
$D_{all,i}(d_a,t)$	All-pathway annual dose from internal and external exposure to radionuclide *i* for an ash deposition thickness d_a at time *t* following a volcanic eruption
$D_{all,i}$	Annual dose from external exposure, radon inhalation, and ingestion of radionuclide *i*, following a volcanic eruption
$D_{inh,p,i}$	Annual dose from inhalation exposure to radionuclide *i* resulting from exposure to nominal concentrations of resuspended particles following a volcanic eruption
$D_{inh,v,i}$	Annual dose from inhalation exposure to radionuclide *i* resulting from exposure to elevated, post-eruption concentrations of resuspended particles
d_a	Thickness of contaminated ash/soil layer
$f_{enhance}$	Enhancement factor for the activity concentration of suspended particulates
$f(t)$	Mass loading time function
n	Index of environments
S	Annual average mass loading for crops
S_n	Annual average mass loading in environment *n*
$S_n(t)$	Total average annual mass loading in environment *n* at time *t* following a volcanic eruption
$S_{v,n}$	Elevated, post-volcanic annual average mass loading in environment *n* in excess of the nominal concentration the first year following a volcanic eruption
$S_{0,TI}$	Average annual mass loading for time interval *TI*
TI	Time interval
t	Time
t_n	Time spent in environment *n*
v	Post-volcanic period when mass loading concentrations are elevated
λ	Mass loading decrease constant

1. PURPOSE

This analysis is one of the nine reports that support the Environmental Radiation Model for Yucca Mountain Nevada (ERMYN) biosphere model. The *Biosphere Model Report* (BSC 2003a) describes in detail the conceptual model as well as the mathematical model and its input parameters. This report documents a set of input parameters for the biosphere model, and supports the use of the model to develop biosphere dose conversion factors (BDCFs). The biosphere model is one of a series of process models supporting the Total System Performance Assessment (TSPA) for a Yucca Mountain repository.

This report, *Inhalation Exposure Input Parameters for the Biosphere Model*, is one of the five reports that develop input parameters for the biosphere model. A graphical representation of the documentation hierarchy for the ERMYN is presented in Figure 1-1. This figure shows the interrelationships among the products (i.e., analysis and model reports) developed for biosphere modeling, and the plan for development of the biosphere abstraction products for TSPA, as identified in the *Technical Work Plan: for Biosphere Modeling and Expert Support* (BSC 2003b). It should be noted that some documents identified in Figure 1-1 may be under development at the time this report is issued and therefore not available at that time. This figure is included to provide an understanding of how this analysis report contributes to biosphere modeling in support of the license application, and is not intended to imply that access to the listed documents is required to understand the contents of this analysis report.

This analysis report defines and justifies values of mass loading, which is the total mass concentration of resuspended particles (e.g., dust, ash) in a volume of air. Measurements of mass loading are used in the air submodel of ERMYN to calculate concentrations of radionuclides in air surrounding crops and concentrations in air inhaled by a receptor. Concentrations in air to which the receptor is exposed are then used in the inhalation submodel to calculate the dose contribution to the receptor from inhalation of contaminated airborne particles. Concentrations in air surrounding plants are used in the plant submodel to calculate the concentrations of radionuclides in foodstuffs contributed from uptake by foliar interception.

Two sets of mass loading values are developed in this analysis. The first is representative of nominal, current and future concentrations of resuspended particles in the Yucca Mountain region. In this report, nominal refers to air-quality conditions in the reference biosphere not measurably affected by a volcanic eruption at Yucca Mountain. This set of mass loading values is used in the biosphere groundwater exposure scenario to calculate the dose caused by inhalation and crop interception of resuspended soil contaminated by well water. This set is also used in the biosphere volcanic ash exposure scenario to calculate the dose caused by inhalation and interception of nominal concentrations of resuspended, contaminated ash following a volcanic eruption. The second set of mass loading values is representative of the increase in mass loading expected after a volcanic eruption at Yucca Mountain and is used in the biosphere volcanic ash exposure scenario to calculate the inhalation and ingestion doses following an eruption. Note that biosphere exposure scenarios are not equivalent to scenario classes used in the TSPA.

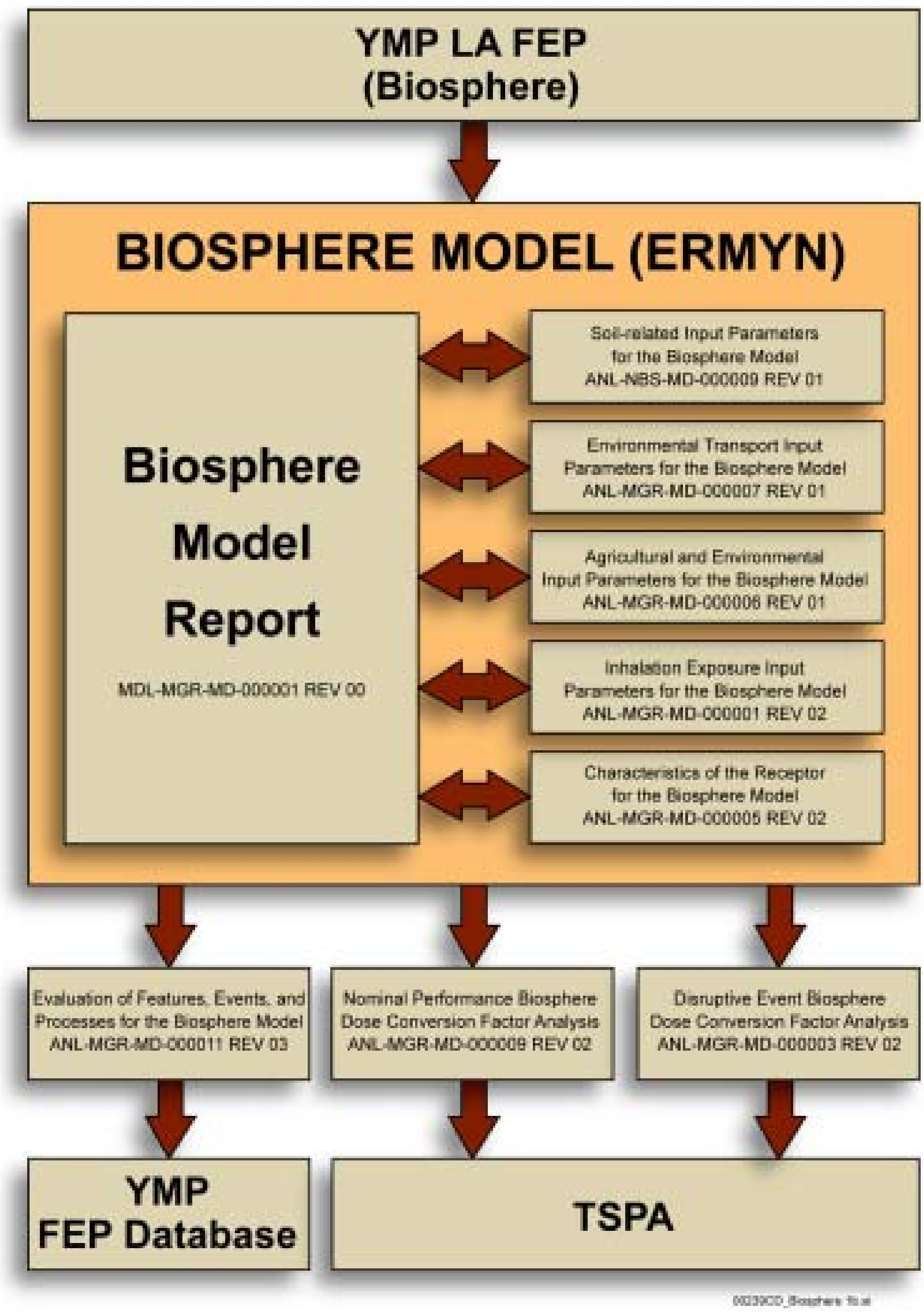


Figure 1-1. Documentation Hierarchy for the Environmental Radiation Model for Yucca Mountain Nevada

In addition, the mass loading time function and the parameter mass loading decrease constant are developed in this analysis. This function describes how mass loading changes over time following a volcanic eruption. The decrease constant defines the rate of change in mass loading following an eruption. They are used directly in the TSPA model to account for changes in BDCFs caused by a decrease in mass loading through time following an eruption.

To summarize, the following parameters are developed in this report.

Mass loading – receptor environments, S_n (mg/m^3). The average annual mass concentration of suspended particles in *n* environments.

Mass loading – crops, S (mg/m^3). The average annual mass concentration of suspended particles in agricultural fields and gardens to which food and forage crops are exposed.

Mass loading decrease constant, λ (1/year). Proportion of resuspended particles present at the beginning of a year that are not readily resuspendable at the end of the year. This parameter and the associated mass loading time function are applicable only to the volcanic ash exposure scenario.

These parameters support treatment of the features, events, and processes (FEPs) listed in Table 1-1. See the *Biosphere Model Report* (BSC 2003a, Section 6.2) for information on the inclusion and exclusion of FEPs in the biosphere model.

This report includes part of the technical justification required to address four issues related to the consequences of igneous activities (Crump 2001, Attachment 1). First, information is included in Sections 5 and 6 to document the relationship between static measurements of mass loading used in this analysis (i.e., measurements from stationary monitoring sites) and expected types and durations of surface-disturbing activities associated with the habits and lifestyles of the receptor. Static measurements are used in this analysis primarily to develop distributions of mass loading for the inactive outdoor environment. The applicability of those measurements to the reference biosphere and habits and lifestyles of the receptor are discussed in Sections 6.1.2 and 6.2.2. Those measurements also were extrapolated to develop mass loading concentrations for crops, as described in Sections 5.1, 6.1.5, and 6.2.5. Static measurements of mass loading were used to a lesser extent to develop distributions of mass loading in the active indoor environment (Sections 6.1.3 and 6.2.3) and asleep indoor environment (Sections 6.1.4 and 6.2.4).

Second, information is provided to clarify how concentrations of particles with a mass median aerodynamic diameter $\leq$10 μm (PM_{10}) have been extrapolated to concentrations of total suspended particles (TSP), including considerations of the difference in behavior between PM_{10} and TSP particulates under static and disturbed conditions. In this analysis, concentrations of PM_{10} (or smaller particles) were converted to TSP concentrations if too few measurements of TSP were available to fully understand the range of variation of mass loading within an environment. When that was done, a ratio of TSP to PM_{10} was selected based on the activities and levels of disturbance expected to occur within the environment, as described throughout Section 6 (e.g., Sections 6.1.3.2 and 6.1.4.2).

Table 1-1. Parameters and Related FEPs[a]

Parameter	Related FEPs	FEP Number	Biosphere Submodel	Summary of Disposition in TSPA[b]
Mass Loading – Receptor Environments	Ashfall	1.2.04.07.0A	Air	The treatment of this parameter is described in Sections 6.1 and 6.2 and summarized in Table 7-1.
	Human lifestyle	2.4.04.01.0A		
	Wild and natural land and water use	2.4.08.00.0A		
	Agricultural land use and irrigation	2.4.09.01.0B		
	Urban and Industrial Land and Water Use	2.4.10.00.0A		
	Atmospheric transport of contaminants	3.2.10.00.0A		
Mass Loading – Crops	Ashfall	1.2.04.07.0A	Plant	The treatment of this parameter is described in Sections 6.1.5 and 6.2.5. and summarized in Table 7-1.
	Agricultural land use and irrigation	2.4.09.01.0B		
	Atmospheric transport of contaminants	3.2.10.00.0A		
Mass Loading Time Function and Decrease Constant	Ashfall	1.2.04.07.0A	N/A[c]	The treatment of this parameter is described in Sections 6.3 and summarized in Table 7-1.
	Soil and sediment transport in the biosphere	2.3.02.03.0A		
	Inhalation	3.3.04.02.0A		

Notes: [a] FEPs (features, events, and processes) are listed in DTN MO0301SEPFEPS1.000.
[b] The effects of the related FEPs are included in the TSPA through the BDCFs. See BSC (2003, Section 6.2) for a complete description of the inclusion and treatment of FEPs in the biosphere model.
[c] This parameter is used directly in the TSPA, not in the biosphere model.

The third issue is related to whether methods used in the TSPA to sample BDCFs for post-volcanic conditions are conservative in evaluating long-term ash remobilization processes. The influence of remobilization of ash on changes in mass loading following a volcanic eruption is discussed in Section 6.3.3. Additional information on how the influence of remobilization will be incorporated into the TSPA for the license application is discussed in other documents, such as the *Biosphere Model Report* (BSC 2003a).

The fourth issue is related to the method used in TSPA to calculate how tephra thickness affects mass loading during the post-volcanic period. Development of a mass loading time function and decrease constant that incorporates uncertainty about the influence of ash depth on mass loading is discussed in Section 6.3.3.

Two climate states are considered in this analysis, modern interglacial (current) and glacial transition (future). These climates and their predicted occurrence at Yucca Mountain in the future are described in *Future Climate Analysis* (USGS 2001). The modern interglacial climate includes current conditions, which are characterized by hot, dry summers; warm winters; and low precipitation (USGS 2001, pp. 66 to 67). This climate state is referred to as current climate in this report. The glacial transition climate is characterized by cool, wet winters and warm to cool dry summers relative to current conditions (USGS 2001, p. 73) and is referred to as future climate in this report. As described in Section 6, the same parameter distributions are recommended for both climate states.

This analysis was conducted according to AP-SIII.9Q (*Scientific Analyses*), and an approved development plan (BSC 2003b).

2. QUALITY ASSURANCE

Development of this report involves analysis of data to support performance assessment, as described in the Technical Work Plan (BSC 2003b), and thus is a quality affecting activity in accordance with AP-2.27Q. Approved quality assurance procedures identified in the Technical Work Plan (BSC 2003b, Section 4) have been used to conduct and document the activities described in this report. Electronic data used in this analysis were controlled in accordance with the methods specified in the Technical Work Plan (BSC 2003b, Section 8).

This analysis did not require classification of the quality level of natural barriers or other items in accordance with AP-2.22Q, *Classification Criteria and Maintenance of the Monitored Geologic Repository Q List,,* or other applicable implementing procedures.

3. USE OF SOFTWARE

The only software used to manipulate or analyze data were the commercial off-the-shelf products Microsoft ® Access 97 SR-2 and Excel 97 SR-2. All methods used within Access and Excel to manipulate or combine data, and associated formulas, inputs, and outputs, are described in the text or tables of this report. The average and standard deviation (sd) functions of Excel were used throughout this analysis to calculate summary statistics and Excel graphics functions were used to create figures.

4. INPUTS

4.1 DATA AND OTHER TECHNICAL PRODUCT INPUTS

The technical product inputs directly relied upon to develop values for each parameter are described and justified below and summarized in Table 4-1.

4.1.1 Airborne Particle Concentrations

Measurements of airborne particle concentrations reported within the external sources listed in Table 4-2 were used to develop distributions of mass loading in the active outdoor, inactive outdoor, active indoor, and asleep indoor environments applicable to the biosphere model. These measurements were not collected in the rural, arid environment of Amargosa Valley; therefore, uncertainty about the influence of climate, environment, activity patterns, and other factors must be considered when applying these data to the biosphere model. Description of these measurements, their use in this analysis, and uncertainty associated with their use, is further described in Sections 5.2, 6.1, 6.2, and 6.3. Applicable mean or other representative values from the publications included in this data set are presented in Tables 6.1.1-1, 6.1.3-1, and 6.1.4-1.

Table 4-1. Technical Product Inputs

Input	Source of Input	Parameter[a]	Description
Resuspended particle concentrations and ratios	Peer-reviewed publications listed in Table 4-2	N/A	External-source measurements of TSP or other airborne particulate concentrations taken in the environments considered in the biosphere model
Resuspended particle concentrations	EPA AIRdata database (MO0210SPATSP01.023)	• Particle Characteristics	Annual average TSP concentrations at monitoring sites throughout the United States, 1970–2001
Resuspended particle concentrations	EPA AIRdata database (MO0008SPATSP00.013)	• Particle Characteristics	24-hour concentrations of TSP at monitoring sites in Washington, 1979–1982
Resuspended particle concentration ratios	MO98PSDALOG111.000 TM000000000001.039 TM000000000001.041 TM000000000001.042 TM000000000001.043 TM000000000001.079 TM000000000001.082 TM000000000001.084 TM000000000001.096 TM000000000001.097 TM000000000001.098 TM000000000001.099 TM000000000001.105 TM000000000001.108	• Particle Characteristics	24-hour concentrations of TSP and PM_{10} at two sites in Yucca Mountain, 1989–1997.
Climate	National Climatic Data Center (NCDC 1998a, 1998b)	N/A	Average annual precipitation and snowfall, and other measurements of climate at weather stations in the United States through 1997

[a] Applicable parameter in the Technical Data Parameter Dictionary

This data set includes original measurements of resuspended particle concentrations from all publications known to the author of this analysis that met the following requirements; therefore, it is a comprehensive collection of applicable information. These requirements were selected to ensure that the data are technically defensible and applicable to this analysis.

- The information was published in a peer-reviewed scientific journal.
- The methods used to measure particulate concentrations were sufficiently described to determine whether the methods and equipment used were applicable to this analysis and comparable to other studies.
- Measurements were made in a setting applicable to this analysis (e.g., outdoor settings during dust-disturbing activities, indoor settings with and without activity).

In addition, because mass loading is defined as the concentration of all resuspended particles, most of the sources included in this data set report concentrations of TSP or PM_{10}. Because of the small number of measurements reported for the active outdoor environment, asleep indoor environments, and post-volcanic environments, sources that report concentrations of smaller particles (e.g., particles with a mass median aerodynamic diameter ≤4 μm [PM_4] or ≤2.5 μm [$PM_{2.5}$]) in those environments also were included. Sources that report concentrations of $PM_{2.5}$

Table 4-2. Sources of Published Measurements of Resuspended Particle Concentrations

Source	Source
Baxter et al. 1999	Molocznik and Zagorski 1998
Brauer et al. 2000	Molocznik and Zagorski 2000
Brook et al. 1997	Monn et al. 1997
Buist et al. 1983	Mozzon et al. 1987
Buist et al. 1986a	Nieuwenhuijsen and Schenker 1998
Buist et al. 1986b	Nieuwenhuijsen et al. 1998
Clausnitzer and Singer 1997	Nieuwenhuijsen et al. 1999
Clayton et al. 1993	Pellizzari et al. 1999
Evans et al. 2000	Quackenboss et al. 1989
Howard-Reed et al. 2000	Rojas-Bracho et al. 2000
Janssen et al. 1998	Searl et al. 2002
Kullman et al. 1998	Thatcher et al. 1995
Leaderer et al. 1999	Wheeler et al. 2000
Linn et al. 1999	Wigzell et al. 2000
Lioy et al. 1990	Williams et al. 2000
Long et al. 2000	Yano et al. 1990
Long et al. 2001	Yocom et al. 1971
Merchant et al. 1982	

in the other environments considered in the biosphere model were not included because sufficient measurements of TSP and PM_{10} were available. Also, sources that report concentrations for environments not considered in the biosphere model were not included.

No requirement was included concerning the accuracy or precision of the data because the mass loading distributions developed in this analysis have a relatively large range and are therefore insensitive to the much smaller levels of error in measurement of airborne particle concentrations. For example, limits of detectability of equipment commonly used to measure mass loading are generally less than 0.01 mg/m^3 and sampling precision generally is less than 0.02 mg/m^3 (Howard-Reed et al. 2000, p. 1127; Rojas-Brancho et al. 2000, p. 297; Williams et al. 2000, p. 523).

4.1.2 Total Suspended Particles – United States

Annual average concentrations of TSP for sites throughout the United States during 1970 through 2001 (DTN MO0210SPATSP01.023) were used to determine mass loading in the outdoor inactive environment (Section 6.1.2). The data were obtained from the U.S. Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards AirData database (Ambrose 2002a,b). This database contains measurements of air pollution concentrations collected by federal, state, and local government agencies to track compliance with emission standards. These data were collected and reported in accordance with EPA requirements for methodology and quality control and therefore were collected using consistent methods that meet federal quality control standards. See Section 6.1.2 for additional information on the appropriateness of these data for their intended use. Selection of the subset of data used in this analysis is described in Section 6.1.2.1, and those data are displayed in Appendix B.

4.1.3 Total Suspended Particles − Washington

Twenty-four-hour concentrations of TSP during 1979−1982 from air quality monitoring sites in Washington with high ash fall from the eruption of Mount St. Helens (DTN: MO0008SPATSP00.013) were used in Sections 6.2.2 and 6.3 to predict changes in mass loading following a volcanic eruption. These data were obtained from the EPA AirData database and therefore were collected using consistent methods that meet federal quality control standards. Selection of the subset of data used in this analysis is described in Section 6.2.2.1. See Section 6.2.2 and 6.3 for additional justification on the appropriateness of these data and for caveats about the interpretation of the data for their intended use. Data used in this analysis is displayed in Appendix D.

4.1.4 Resuspended Particles – Yucca Mountain

All valid 24-hour concentrations of PM_{10} and TSP measured concurrently using co-located monitoring equipment at Yucca Mountain during 1989 through 1997 were used in Section 6.1.3.1 to calculate a ratio of TSP to PM_{10} for the Yucca Mountain region. See Table 4-1 for a list of DTNs containing these data. These data are appropriate because they were collected in areas with soils typical of those in Amargosa Valley (CRWMS M&O 1999a, Figure 1 on pp. 2 and 3) and therefore are consistent with relatively undisturbed conditions of the Yucca Mountain region. In addition, these measurements are comparable to data collected elsewhere in the United States because they were taken in accordance with EPA requirements for methodology and quality control. The data are displayed in Appendix E. Deletion of 24 invalid ratios with a TSP:PM_{10} ratio of less than or equal to 1 is discussed in Section 6.1.3.1.

4.1.5 Precipitation – United States

Measurements of average annual precipitation at weather stations in the western U.S obtained from the National Oceanic and Atmospheric Administration, National Climatic Data Center (NCDC 1998a,b) were used in Section 6.1.2 and Appendices B and C to aid in selecting analog air quality monitoring sites representative of arid farming communities. This information also was used throughout Section 6 to describe the climate at weather stations analogous to future conditions predicted for Yucca Mountain. These measurements were collected using the standardized methods and equipment required by the National Climatic Data Center; therefore, they are valid for comparison among sites in the United States. Data used in this analysis are displayed in Appendix B.

4.2 CRITERIA

Table 4-3 lists the requirements from the *Project Requirements Document* (Canori and Leitner 2003a) that are applicable to this analysis. These requirements are for compliance with applicable portions of 10 CFR 63, which is described in more detail in Section 4.3.

Table 4-3. Requirements Applicable to this Analysis

Requirement Number	Requirement Title	Related Regulation
PRD-002/T-015	Requirements for Performance Assessment	10 CFR 63.114
PRD-002/T-026	Required Characteristics of the Reference Biosphere	10 CFR 63.305
PRD-002/T-028	Required Characteristics of the Reasonably Maximally Exposed Individual	10 CFR 63.312

Notes: From Canori and Leitner (2003, Table 2-3).

Table 4-4 lists the acceptance criteria from Section 4.2.1.3.14 (Biosphere Characteristics) of the *Yucca Mountain Review Plan, Draft Final Report* (NRC 2003) based on meeting the requirements of 10 CFR 63.114, 63.305, and 63.312 as they relate to biosphere characteristics modeling. These criteria are listed to further describe how the requirements referenced in Table 4-3 should be met. Only those bulleted items from Section 4.2.1.3.14 of the *Yucca Mountain Review Plan* that apply to this analysis are included here. Similar acceptance criteria and descriptions from Sections 4.2.1.3.11 (Airborne Transport of Radionuclides) and 4.2.1.3.13 (Redistribution of Radionuclides in Soil) of the plan also apply to portions of this analysis.

Table 4-4. Acceptance Criteria from the *Yucca Mountain Review Plan* (NRC 2003) Applicable to this Analysis.

Acceptance Criterion 1 – System Description and Model Integration Are Adequate.

1. Total system performance assessment adequately incorporates important site features, physical phenomena, and couplings, and consistent and appropriate assumptions throughout the biosphere characteristics modeling abstraction process;
2. The total system performance assessment model abstraction identifies and describes aspects of the biosphere characteristics modeling that are important to repository performance, and includes the technical bases for these descriptions. For example, the reference biosphere should be consistent with the arid or semi-arid conditions in the vicinity of Yucca Mountain;
3. Assumptions are consistent between the biosphere characteristics modeling and other abstractions. For example, the U.S. Department of Energy should ensure that the modeling of features, events, and processes, such as climate change, soil types, sorption coefficients, volcanic ash properties, and the physical and chemical properties of radionuclides are consistent with assumptions in other total system performance assessment abstractions;

Acceptance Criterion 2 – Data Are Sufficient for Model Justification.

1. The parameter values used in the license application are adequately justified (e.g., behaviors and characteristics of the residents of the Town of Amargosa Valley, Nevada, characteristics of the reference biosphere, etc.) and consistent with the definition of the reasonably maximally exposed individual in 10 CFR Part 63. Adequate descriptions of how the data were used, interpreted, and appropriately synthesized into the parameters are provided; and
2. Data are sufficient to assess the degree to which features, events, and processes related to biosphere characteristics modeling have been characterized and incorporated in the abstraction. As specified in 10 CFR Part 63, the U.S. Department of Energy should demonstrate that features, events, and processes, which describe the biosphere, are consistent with present knowledge of conditions in the region, surrounding Yucca Mountain. As appropriate, the U.S. Department of Energy sensitivity and uncertainty analyses (including consideration of alternative conceptual models) are adequate for determining additional data needs, and evaluating whether additional data would provide new information that could invalidate prior modeling results and affect the sensitivity of the performance of the system to the parameter value or model.

Table 4-4. (Continued)
Acceptance Criterion 3 – Data Uncertainty Is Characterized and Propagated Through the Model Abstraction.
1. Models use parameter values, assumed ranges, probability distributions, and bounding assumptions that are technically defensible, reasonably account for uncertainties and variabilities, do not result in an under-representation of the risk estimate, and are consistent with the definition of the reasonably maximally exposed individual in 10 CFR Part 63;
2. The technical bases for the parameter values and ranges in the abstraction, such as consumption rates, plant and animal uptake factors, mass-loading factors, and biosphere dose conversion factors, are consistent with site characterization data, and are technically defensible;
3. Process-level models used to determine parameter values for the biosphere characteristics modeling are consistent with site characterization data, laboratory experiments, field measurements, and natural analog research;
4. Uncertainty is adequately represented in parameter development for conceptual models and process-level models considered in developing the biosphere characteristics modeling, either through sensitivity analyses, conservative limits, or bounding values supported by data, as necessary. Correlations between input values are appropriately established in the total system performance assessment, and the implementation of the abstraction does not inappropriately bias results to a significant degree;
5. Where sufficient data do not exist, the definition of parameter values and conceptual models is based on appropriate use of expert elicitation, conducted in accordance with appropriate guidance, such as NUREG-1563. If other approaches are used, the U.S. Department of Energy adequately justifies their uses; and
6. Parameters or models that most influence repository performance, based on the performance measure and time period of compliance specified in 10 CFR Part 63, are identified.
Notes: From NRC 2003 (Section 4.2.1.3.14, Biosphere Characteristics). Only those acceptance criteria and related explanations that apply to this analysis are listed. Note that similar acceptance criteria in Sections 4.2.1.3.11 (Airborne Transport of Radionuclides) and 4.2.1.3.13 (Redistribution of Radionuclides in Soils) also apply to this analysis.

4.3 CODES AND STANDARDS

The following section of the Nuclear Regulatory Commission's regulations for disposal of spent nuclear fuel and high level radioactive wastes in the proposed geologic repository at Yucca Mountain (10 CFR 63) are most relevant to this analysis.

϶63.305 Required characteristics of the reference biosphere.

(a) *Features, events, and processes that describe the reference biosphere must be consistent with present knowledge of the conditions in the region surrounding the Yucca Mountain site.*

(b) *DOE should not project changes in society, the biosphere (other than climate), human biology, or increases or decreases of human knowledge or technology. In all analyses done to demonstrate compliance with this part, DOE must assume that all of those factors remain constant as they are at the time of submission of the license application.*

(c) *DOE must vary factors related to the geology, hydrology, and climate based upon cautious, but reasonable assumptions consistent with present knowledge of factors that could affect the Yucca Mountain disposal system over the next 10,000 years.*

(d) *Biosphere pathways must be consistent with arid or semi-arid conditions.*

϶63.312 Required characteristics of the reasonably maximally exposed individual.

The reasonably maximally exposed individual is a hypothetical person who meets the following criteria: …

(b) Has a diet and living style representative of the people who now reside in the Town of Amargosa Valley, Nevada. DOE must use projections based upon surveys of the people residing in the Town of Amargosa Valley, Nevada, to determine their current diets and living styles and use the mean values of these factors in the assessments conducted for ϶϶63.311 and 63.321.

5. ASSUMPTIONS

5.1 MASS LOADING—CROPS

It is assumed that the distribution of mass loading in fields where crops are growing is similar to or higher than that in the inactive outdoor environment, with a minimum value equal to the minimum value of the inactive outdoor environment, and a modal and maximum value twice that of the inactive outdoor environment.

This assumption is used in Sections 6.1.5 and 6.2.5 to develop distributions of mass loading for crops. This assumption is necessary because concentrations of resuspended particles have not been measured in fields with growing crops. See Section 6 for a description of environments.

Dust concentrations during the latter part of the growing season, rather than the entire season, must be considered for development of the mass loading distribution for crops because dust deposited on the surface of plants quickly falls off, washes off, or is otherwise removed relatively rapidly (Till and Meyer 1983, pp. 5-36 and 5-37; IAEA 2001, p. 64), and because harvested foodstuffs and forage usually are not present early in the season. Therefore, planting, plowing, weeding, berming, and other soil-disturbing activities that occur early in growing seasons will have little influence on uptake of radionuclides into foodstuffs via dust deposition. Few soil-disturbing activities except harvesting usually occur during the latter part of growing seasons, especially for plants such as alfalfa, wheat, orchard crops, and garden vegetables commonly grown in Amargosa Valley and eastern Washington (the analog site for consideration of future climates, USGS 2001, pp. 62-75). The increase in mass loading during harvesting will occur over a very short period relative to the remainder of the period for which radionuclide concentrations on plant surfaces are considered and much of the dust deposited during harvesting may be removed during field processing of crops. Because fields and gardens are infrequently disturbed and frequently irrigated during the latter part of the growing season, there should be few sources of resuspended particles in the immediate vicinity of plants and mass loading therefore will be influenced most by particle resuspension in the region surrounding the fields and gardens.

The mass loading distribution for the nominal, inactive outdoor environment was developed from measurements of airborne particulate concentrations at stationary monitors in farming communities in the western United States (Section 6.1.2). Those measurements were influenced by resuspended dust from agricultural fields and agricultural activities in the general vicinity of monitoring stations, but not necessarily at the station locations. Therefore, they generally match the conditions required to estimate mass loading concentrations for crops.

For the following reasons it is likely that mass loading concentrations in some fields are higher than measurements from stationary, community monitors. Crops may be located closer to sources of resuspended particles (e.g., dirt roads, recently plowed fields) than community monitors and some increase in airborne particle concentrations will occur during harvesting. Also, stationary monitors usually are located about 1.5 m above the ground surface, and therefore do not measure airborne particulate concentrations where most plants grow. Mass loading near the ground surface is expected to be higher than at 1.5 m because it takes less force (i.e., less wind) to resuspend a particle a short distance off of the ground. To account for uncertainty in these differences between the environment around crops and the locations where community monitors are located, it is assumed that the modal and maximum values of the distribution of mass loading for crops are twice that of the distribution for the inactive outdoor environment. A higher multiplier was not chosen because mass loading rapidly returns to background levels after soil-disturbing activities cease (Pinnick et al. 1985, p. 104) and because the influence of soil disturbing activities on mass loading generally is limited to less than 0.75 km (Chow et al. 1999, p.652). Thus, for most of the time, there will be few or no soil-disturbing activities influencing mass loading near crops.

The minimum value of the distribution of mass loading for crops is assumed to be equal to the minimum value of the inactive outdoor environment primarily because it is likely that some crops are located in situations very similar to community monitors; therefore, concentrations measured by those monitors (and used to estimate mass loading in the inactive outdoor environment) will be similar to concentrations for those crops. In addition, some crops such as alfalfa cover almost the entire ground surface; therefore, there would be very little wind erosion in the immediate vicinity of the plants prior to harvesting.

This assumption does not need to be confirmed because it is based on a reasonable, cautious interpretation of conditions that accounts for uncertainty in mass loading for crops.

5.2 POST-VOLCANIC INDOOR CONCENTRATIONS

It is assumed that changes in outdoor concentrations of mass loading following a volcanic eruption have a proportional affect on mass loading in indoor environments.

This assumption is used in Section 6.2.3 and 6.2.4 to develop distributions of mass loading in the active indoor and asleep indoor environments for the first year following a volcanic eruption. This assumption is necessary because there are few measurements of mass loading indoors following a volcanic eruption.

This assumption is based on published comparisons of indoor and outdoor concentrations of particulate matter. The studies reviewed were selected as described in Section 4.1.1, and are the same as those described in Sections 6.1.3 to evaluate concentrations in the active indoor environments. See Section 6.1.3 for a description of the studies.

Eleven of the seventeen studies reviewed in Section 6.1.3 included correlation or regression coefficients of indoor and outdoor concentrations (Table 5-1). These coefficients ranged from 0.08 to 0.96, and most were between 0.25 and 0.75. Five of seven studies that included statistical tests of correlation coefficients reported that the correlations were significant. Outdoor concentrations were relatively low in the two studies that reported no significant correlation (Leaderer et al. 1999, Table 2; Rojas-Bracho et al. 2000, Table 2). Factors such as amount of smoking, cooking, and personal activity were listed in many studies as explanations why indoor and outdoor correlations were relatively low.

Seven studies reported the slope of the regression between indoor or personal and outdoor concentrations (Table 5-1). Eight of ten slopes reported were between 0.39 and 0.55, indicating that in those studies, an increase in outdoor concentrations resulted in an increase of about half

Table 5-1. Correlation Coefficients (*R*) of Indoor and Personal versus Outdoor Concentrations of Airborne Particles

Reference	*R*	*P*[a]	Slope[b]	Comparison[c]
Clayton et al. 1993, Table 3	0.35			Personal:Ambient PM_{10}, day
	0.62			Personal:Ambient PM_{10}, night
	0.46			Indoor:Ambient $PM_{2.5}$, day
	0.65			Indoor:Ambient $PM_{2.5}$, night
Lioy et al. 1990, p. 62	0.67	<0.01	0.50	Indoor:Ambient PM_{10}
Quackenboss et al. 1989, Figure 2	0.42		1.14	Indoor:Ambient PM_{10}, includes smokers
Leaderer et al. 1999, Table 2, Figure 2	0.29	>0.10		Indoor:Outdoor PM_{10}
	0.11	>0.10		Indoor:Ambient PM_{10}
	0.53	<0.01	0.43	Indoor:Outdoor $PM_{2.5}$
	0.08	>0.10		Indoor:Ambient $PM_{2.5}$
Long et al. 2000, Figure 7	0.20	<0.001		Indoor:Outdoor $PM_{2.5-10}$, day
	0.65	<0.001		Indoor:Outdoor $PM_{2.5-10}$, night
Pellizzari et al. 1999, Figure 3	0.23	<0.01		Personal:Outdoor $PM_{2.5}$
	0.19	<0.01		Personal:Ambient $PM_{2.5}$
	0.33	<0.01		Indoor:Outdoor $PM_{2.5}$
	0.21	<0.01		Indoor:Ambient $PM_{2.5}$
Janssen et al. 1998, Table 3	0.71	<0.01	0.55	Personal:Ambient PM_{10}
	0.75	<0.01	0.47	Indoor:Outdoor PM_{10}
Evans et al. 2000, Table 10	0.75			Indoor:Outdoor PM_{10}
	0.67			Indoor:Ambient PM_{10}
Williams et al. 2000, Table 9	0.96	<0.001	0.39	Apartment:Outdoor $PM_{2.5}$
	0.96	<0.001	0.40	Apartment:Ambient $PM_{2.5}$
Linn et al. 1999, Table 3 and p. 112	0.66		0.87	Personal:Outdoor PM_{10}
	0.54		0.22	Indoor:Ambient PM_{10}
Rojas-Bracho et al. 2000, Table 5	0.41	>0.05	0.43	Personal:Ambient PM_{10}

Notes: [a] Probability of null hypothesis that there is no correlation between indoor and outdoor concentrations.
[b] Slope of regression of indoor/personal and outdoor concentrations.
[c] "Personal" concentrations were measured near head of subjects; "Apartment and Indoor" concentrations were measured at stationary indoor sites; Outdoor concentrations were measured at stationary sites outdoors near homes; and "Ambient" concentrations were measured at regional, stationary sites.

that amount in indoor concentrations. The only study reporting a slope greater than 1 (Quackenboss et al. 1989) included a substantial number of smokers. It is expected that concentrations inside the homes of smokers would be high relative to outdoor concentrations because smoking generates a large concentration of particles.

In summary, the results of these studies indicate that an increase in outdoor concentrations usually will result in an increase in indoor concentrations, although the magnitude of changes indoors likely will be less than those outdoors, and that other factors, such as the amount of smoking, cooking and other indoor activities also influence the relationship between indoor and outdoor concentrations.

There is some uncertainty in applying the results of these studies to post-volcanic conditions that may occur near Yucca Mountain. It is predicted that modal TSP concentrations outdoors would double from 0.060 mg/m^3 to 0.120 mg/m^3 the first year after a volcanic eruption (Section 6.2.2). Few of the studies listed in Table 5-1 were conducted when outdoor concentrations were that high, and none were conducted during a period when concentrations remained high for long. It is possible that a large increase in TSP outdoors, or high concentrations outdoors for most of the year, would result in a larger change in indoor TSP than indicated by the regression slopes listed in Table 5-1. For example, air filtering systems could become overwhelmed or larger amounts of dust could be tracked indoors, resulting in higher concentrations indoors. It contrast, people may dust and vacuum more often or keep their windows closed to reduce dust concentrations. To account for this uncertainty, and ensure that indoor concentrations following a volcanic eruption are not underestimated, it is assumed that indoor concentrations will increase proportionally to outdoor concentrations.

This assumption does not require further confirmation because it is based on a reasonable, cautious interpretation of a sufficient quantity of published, accepted information that accounts for important sources of uncertainty.

6. ANALYSIS

This section describes how mass loading values are used in the biosphere model to calculate inhalation doses. The following sections then describe development of the mass loading parameters for the biosphere groundwater scenario (Section 6.1) and the volcanic ash scenario (Section 6.2). Use of the mass loading time function and decrease constant in the TSPA model, and development of that parameter, is described in Section 6.3.

In general, mass loading distributions were developed based on concentrations of resuspended particles measured in environments or conditions analogous to those considered in the biosphere model. Alternatively, mass loading distributions could have been developed using a soil resuspension model (e.g., Anspaugh et al. 1975). Although resuspension models were examined to select the shape of the mass load decay function for the volcanic eruption parameters, resuspension models were not used to calculate mass loading values because available models require numerous site- and situation-specific parameter values that generally are not available and the accuracy of the models is not well understood (Garger et al. 1997). In addition, mass loading values based on representative measurements of resuspended particles are more conservative than soil resuspension models because it is assumed that all resuspended soil particles (groundwater scenario) or resuspended ash (volcanic ash scenario) are contaminated. This would not be true, especially for nominal conditions, because some airborne particulate matter is generated over a large up-wind area, and most of the soil in that area would not be contaminated.

The mass loading distributions presented in this report are intended for use in modeling of both current (modern interglacial) and future (glacial transition) climatic conditions. Average annual precipitation at Yucca Mountain currently is about four to six inches (CRWMS M&O 1999b, Appendix A) and snowfall is rare. It is predicted that the future, glacial transition climate that will occur at Yucca Mountain during most of the next 10,000 years will be similar to or drier than that currently found in parts of eastern Washington (USGS 2001, pp. 62 to 75). Analog weather stations for the upper bound of the glacial transition climate state are Spokane (0 annual precipitation = 16.2 inches, 0 annual snowfall = 42.1 inches), Rosalia (0 precipitation = 18.1 inches, 0 snowfall = 24.3 inches), and St. Johns (0 precipitation = 17.1 inches, 0 snowfall = 25.8 inches), Washington (USGS 2001, Table 2) (climate data are from NCDC 1998b). To evaluate the influence of a change from current to predicted future climatic conditions on mass loading, annual average concentrations of TSP at rural agricultural sites with varying amounts of precipitation and snowfall were compared (Appendix C). Sites with less than 20 inches of precipitation and less than about 45 inches of snowfall had very similar concentrations of TSP. Based on this comparison, it is concluded that separate distributions for current and future climatic conditions are not required.

Triangular distributions were selected for all parameters in this analyses for the following reasons.

- Although distributions of dust concentrations for single activities or locations generally are lognormal (Morandi et al. 1988, Section 3.2; Nieuwenhuijsen and Schenker 1998, p. 10; Nieuwenhuijsen et al. 1999, p. 37), little information is available about the shape of mass loading distributions that are representative of annual average exposure for a large group of activities such as those typically conducted in the environments used in the biosphere model

- There is insufficient information to calculate a mean and standard deviation of a lognormal distribution for most parameters.

- Some distributions are developed based on changes in bounds or the central tendency relative to other environments (e.g., the upper bound of mass loading for crops is twice that for the inactive outdoor environment, Assumption 5.1). Moving one bound of a distribution without affecting the central tendency (i.e., mode or average) or other bound is possible for triangular and uniform distributions, but is not possible for many other distributions (e.g., lognormal or normal).

- Uniform distributions are not used because the minimum and maximum values of the distributions were selected to be reasonable end points that have a low probability of occurrence.

Because dust concentrations for single activities generally are lognormal, geometric mean values of airborne particle concentrations presented in publications are reported in this analysis if available; otherwise, arithmetic mean values are reported.

Mass Loading – Receptor Environments–The radionuclide concentrations in air that are used to estimate inhalation doses for the groundwater exposure scenario are calculated in the ERMYN for a series of environments using the following equation (BSC 2003a, Section 6.4.2).

$$Ca_{h,i,n} = f_{enhance}\, Cs_{m,i}\, S_n \qquad \text{Eq. 6-1}$$

where:

$Ca_{h,i,n}$ = Activity concentration of radionuclide *i* in air from soil resuspension for the assessment of human inhalation exposure (*h*) in environment *n* (Bq/m^3).

$f_{enhance}$ = Enhancement factor for the activity concentration of suspended particulates (dimensionless), which accounts for differences between activity concentrations of soil and suspended particles caused by differential resuspension and activity concentrations on small versus large particles.

$Cs_{m,i}$ = Activity concentration of radionuclide *i* in the surface soil per unit of mass (m) (Bq/kg).

S_n = Average annual concentration of TSP in air (mass loading) for evaluation of inhalation exposure for environment *n* (kg/m^3).

N = Index of environments (see below).

The activity concentration is then combined in the inhalation submodel with environment-specific breathing rates, time spent in each environment by the receptor, and radionuclide-specific dose conversion factors to calculate an annual dose from inhalation exposure. Therefore, an increase in mass loading results in a proportional increase in the activity concentrations of radionuclides in the air, which results in an increase in the inhalation dose. The equation used for the volcanic ash scenario is the same except that S_n is calculated as a function of time (BSC 2003a, Section 6.5.2), as described in Section 6.2.

The following receptor environments are considered in the model. They are mutually exclusive and represent the various behavioral and environmental combinations for which a person would receive a substantially different rate of exposure via inhalation or external exposure.

1. **Active Outdoors:** This environment is representative of conditions that occur when a person is outdoors in the contaminated environment conducting dust-generating activities while working (e.g., field preparation, excavating, livestock operations) or recreating (e.g., gardening, landscaping, riding horses or motorbikes). Because dust concentrations decrease rapidly after dust-disturbing activities cease (e.g., Pinnick et al. 1985, pp. 103 and 104), this category is limited to conditions during and shortly after dust-generating activities.

2. **Inactive Outdoors**: Conditions outdoors in the contaminated area when dust-generating activities are not being conducted by the receptor. This category includes time spent commuting within contaminated areas and time spent outdoors in the contaminated areas conducting activities that do not resuspend soil (e.g., sitting, swimming, walking, barbecuing,

equipment maintenance). Commute time is included in this category because major roads in Amargosa Valley are paved, and commuting on those roads would not resuspend much soil.

3. **Active Indoors:** Conditions indoors within the contaminated area when people are at home or at a place of business, including conditions when they are sedentary or active.

4. **Asleep indoors:** Conditions indoors within the contaminated area when people are asleep.

5. **Away from Potentially Contaminated Area:** This category is included to account for time spent away from the potentially contaminated agricultural area (groundwater scenario) or ash blanket (volcanic ash scenario). Because the concentration of radionuclides in this environment is zero, mass loading concentrations are not developed for this environment.

Calculations described in Appendix A were conducted to evaluate the sensitivity of estimates of the mass of resuspended particles inhaled to changes in mass loading and other input parameter values. Total mass of particles inhaled was influenced most by mass loading and time spent in the active outdoor environment. Mass loading in the active indoor environment had a moderate influence on the predicted mass of particles inhaled (Appendix A, Table A-1).

Distributions of mass loading used in the biosphere model must be representative of average exposure over one year as influenced by the full range of reasonable conditions within the biosphere and the average lifestyle characteristics of the receptor. A period of one year is considered because the TSPA calculates annual doses based on time steps of ≥1 year. Because average annual concentrations at a site do not vary much among years (for example see Appendix B, Table B-1), annual concentrations also are representative of exposure over periods of >1 year.

Concentrations of resuspended particles in the receptor environments considered in the model are influenced in part by characteristics of the biosphere, such as soil moisture, the amount of agriculture, and wind conditions. In the biosphere model, parameter distributions are to be representative of all reasonable conditions of the biosphere.

Concentrations of resuspended particles are also influenced by characteristics of the receptor, such as the occupation of Amargosa Valley residents, and typical behaviors of residents within those environments. Therefore, lifestyle characteristics that influence mass loads must be considered in this analysis. 10 CFR 63.312(b) requires that average values of the lifestyle characteristics of the people in the Town of Amargosa Valley be used in the TSPA. For this analysis, these requirements have been interpreted qualitatively to mean that only typical or common behaviors and other lifestyle characteristics should be represented in distributions of mass loads. For example, people with a physical handicap may experience very low concentrations of particulates indoors if they are very sedentary and cannot participate in housework. Because behavioral modifications resulting from such health conditions are not representative of average lifestyle characteristics, associated mass loads should not be included in the distribution of average annual concentrations in the active indoor environment. Also, although most farm workers will do many jobs with a variety of associated concentrations of resuspended particles, a few may specialize in activities that resuspend extreme amounts of dust, such as leveling of fields, a majority of the time. The distribution of annual average concentrations in the outdoor environment should not include the exposure rates of these few workers because they are not representative of average lifestyle characteristics.

Mass Load – Crops–The equation used to calculate radionuclide concentrations in air from which resuspended particles are intercepted by crops is very similar to that used for human inhalation (Eq. 6-1), but does not include an enhancement factor and only considers one environment (i.e., immediately around the crops). Radionuclide concentrations are combined in the plant submodel of ERMYN with the deposition velocity of airborne particulates, radionuclide concentrations in soil, crop yield, and other variables to estimate the concentration of radionuclides in the edible portion of crops resulting from foliar interception of particles (BSC 2003a, Sections 6.4.2 and 6.5.2). In contrast to receptor environments (for which mass loading following a volcanic eruption is treated as a function of time), radionuclide concentrations in the environment surrounding crops are not treated as a function of time for either exposure scenario.

6.1 MASS LOADING – NOMINAL CONDITIONS

This section describes the development of mass loading distributions within the five environments (four receptor environments and the environment around crops) for nominal conditions; i.e., air quality conditions in the reference biosphere not measurably influenced by a volcanic eruption at Yucca Mountain. These values are intended for use in the groundwater exposure scenario. They also are intended for use in the volcanic ash exposure scenario for calculation of BDCFs representative of the period after mass loading concentrations have returned to pre-eruption conditions. See Section 6.2 for a description of that scenario.

For the groundwater exposure scenario, the representative biosphere is a rural community in an arid to semi-arid environment with conditions similar to those in the Yucca Mountain region and a population with lifestyle characteristics similar to those in the Town of Amargosa Valley today (based on requirements in 10 CFR 63.305 and 312, see Section 4.3). The only common potential sources of contaminated, resuspended soil particles for this scenario would be agricultural fields, gardens, and landscapes irrigated with contaminated well water and feedlots, agricultural fields, and other areas where manure and urine from livestock that were fed contaminated forage and water are deposited.

For the volcanic ash exposure scenario during nominal conditions, the sources of contaminated resuspended particles would be ash/waste particles initially deposited during the eruption, ash/waste particles washed into the valley from Fortymile Wash, and ash/waste particles blown into the valley. By definition of the mass loading time function, the tephra deposit will have been stabilized and particles redistributed into the area will be well mixed with other soil by the time nominal conditions occur (see Section 6.2). Thus, resuspension on undisturbed sites will be similar to that prior to the eruption, and the main source of resuspended particles will be agricultural fields and other disturbed sites.

The number and size of agricultural and other disturbed sites in Amargosa Valley is small relative to the size of the inhabited area. The inhabited portion of Amargosa Valley extends south and west of Highway 395 from the Lathrop Wells Junction of Highway 95 to the California border. Most people in Amargosa Valley live in the southern portion of the valley in a triangular area approximately 17 x 17 x 24 km (~150 km^2) in size (BSC 2001, Figure 1). This area, known as the farming triangle, is also where most agriculture in the valley occurs (CRWMS M&O 1999a, pp. 1 to 3). The U.S. Census Bureau estimated that only 26 of 862 Amargosa Valley residents ≥16 years old were employed in agriculture (Bureau of the Census 2002, Table P49). During 1998, there were about 8.9 km^2 (2,199 acres) of commercial agriculture in Amargosa Valley, 8.4 km^2 (2,072 acres) of which was planted at the time agricultural acreage was measured. About 87 percent of all acreage was planted in hay (92 percent of planted acreage) and about 6 percent was orchards or vineyards (YMP 1999, Table 10). During 1999, there were 8.2 km^2 (2,015 acres), 7.3 km^2 (1,798 acres) of which was planted at the time of the survey. Eighty-three percent was planted in hay (93 percent of planted acreage) and 6 percent was orchards or vineyards (YMP 1999, Table 11). Thus, only a small portion of the valley (about six percent of the farming triangle and a much smaller portion of the entire inhabited valley) is planted in agriculture, and most of that is planted in hay, orchards, and vineyards, crops that require infrequent land preparation or other soil disturbances that would resuspend contaminated soil particles. There also is one large dairy near the south end of the agricultural region in Amargosa Valley that had about 4,400 cows in 1998 and 5,000 cows in 1999 (YMP 1999, Tables 8 and 9). About 46% of 195 Amargosa Valley households surveyed during 1997 had a garden (DOE 1997, Tables 2.4.2 and 3.5.1). In summary, Amargosa Valley has a small agricultural industry. Within the valley, large disturbed sites occupy only a small portion of the landscape, although small sites (e.g., gardens) may be found near about 50% of residences.

6.1.1 Active Outdoor Environment

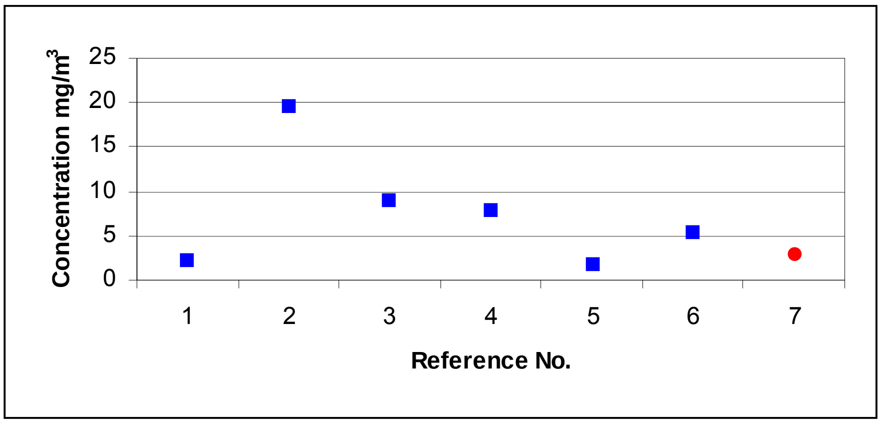
A review of applicable literature (See Section 4.1.1) was conducted to determine the range of average concentrations of particles resuspended while soil disturbing activities were being conducted. Applicable studies are presented below, with the most applicable results presented first. Studies were considered most applicable if they (1) reported particulate concentrations resulting from behaviors similar to those expected by the biosphere model receptor in the active outdoor environment (e.g., farming, excavating), (2) measured and reported concentrations of TSP, and (3) were conducted in arid to semi-arid environments. Only measurements of personal exposure were considered applicable for analysis of this environment. Unless otherwise stated, personal exposure in this and other studies was measured by placing the inlet device of a dust sampler near the head of the person performing the activity (e.g., on a shirt collar); thus, measurements of personal exposure are representative of the concentration of resuspended particles inhaled by that person. A summary of this review is in Table 6.1.1-1.

6.1.1.1 Literature Review

Nieuwenhuijsen et al. (1999) recorded 142 measurements of personal exposure to TSP during farming activities at 10 farms near Sacramento California over 15 months. The mean TSP concentrations of 23 farming activities ranged from 0.30 (scraping cattle stalls) to 45.14 mg/m^3 (machine harvesting of nut trees from an open tractor cab); the average was 4.14 mg/m^3 (Nieuwenhuijsen et al. 1999, Table 2). The dustiest activity would be conducted infrequently in Amargosa Valley, in part because nut orchards occur on <5% of fields in Amargosa Valley (YMP 1999, Tables 10 and 11) and because harvesting only occurs for a short time each year. Only three other activities (machine harvesting vegetables from an open cab, 7.93 mg/m^3; scraping poultry houses, 6.67 mg/m^3; mowing weeds from an open cab, 5.11 mg/m^3) had

Table 6.1.1-1. Particulate Concentrations–Nominal Outdoor Active Environment

Reference		Concentration, mg/m³ 0	Concentration, mg/m³ Range	Comments
1	Nieuwenhuijsen et al. 1999, Table 2	2.19	0.30–7.93	Farming-California, one extreme value excluded
2	Nieuwenhuijsen et al. 1998, Table 2	19.6	0.7–98.6	Farming-California, many activities in open cab
3	Molocznik and Zagorski 1998, Figure 2	9	3.5–13	Farming-Poland, midpoint of ranges for 6 applicable activities
4	Molocznik and Zagorski 2000, p. 47	7.8	2.5–14.4	Farming-Poland, midpoint of ranges for 6 applicable activities
5	Kullman et al. 1998, p. 3	1.78	GSD = 2.9	Dairy barns-Wisconsin
6	Mozzon et al. 1987, p. 115	5.3	0.44–22.8	Landfill operators–Ontario
7	Clausnitzer and Singer 1997, Table 1	2.9	0.2–13.6	Farming-California, respirable concentrations only



Squares = TSP, circle = PM_4

geometric mean values >5 mg/m³. The average of all activities excluding nut harvesting was 2.19 mg/m³.

Nieuwenhuijsen et al. (1998) measured higher levels of personal exposure to TSP during a smaller-scale study of farming operations at three experimental farms near Davis California during April through November. The mean TSP concentrations of 18 farming activities ranged from 0.7 (milking) to 98.6 mg/m³ (disking from an open cab); the average was 19.6 mg/m³ (Nieuwenhuijsen et al. 1998, Table 2). Ten activities had geometric mean values greater than 10 mg/m³; all except cattle feeding and nut harvesting were field preparation or similar activities conducted from an open tractor cab. Concentrations measured during this study may be higher than those reported in the Sacramento study (Nieuwenhuijsen et al. 1999) because the Davis study was conducted only during the dry season and because 10 of the 18 activities were conducted in an open cab. Nieuwenhuijsen and Schenker (1998. p. 11) reanalyzed data from the Davis study and concluded that the presence of an enclosed cab had a very large influence on exposure levels (e.g., exposure during disking was 50 times lower when conducted from an enclosed cab).

Molocznik and Zagorski (1998) measured personal exposure to TSP during seven activities conducted by tractor drivers on large farms and by farmers on small, private farms in Poland. Results are presented in a bar chart (Figure 2 of Molocznik and Zagorski, 1998) as the minimum and maximum average concentrations for seven types of activities (concentrations per activity are reported here as approximated whole numbers because the chart does not present more precise results). The activity with the highest concentrations, 2 to 58 mg/m^3 (indoor occupations, including threshing of wheat indoors), does not apply to this analysis, because indoor threshing of wheat probably is not conducted in Amargosa Valley and because that activity would not result in exposure to a substantial amount of contaminated soil (i.e., only that remaining on the plant surface). The activity with the second highest concentrations was plant harvesting, ranging from about 3 to 35 mg/m^3. The activity with the lowest concentrations was plant protection, ranging from about 2 to 5 mg/m^3. The average of the midpoints of the six applicable values was about 9 mg/m^3, with a range of 3.5 to 13 mg/m^3. Activity budgets per farmer were also recorded and used to calculate average annual exposure to TSP per eight hours of work, which ranged 5.3 to 10.8 mg/m^3 for 10 tractor drivers and 3.6 to 10.7 mg/m^3 for 7 private farmers.

In a similar study of 10 females working on private farms in Poland, average personal exposure to TSP during six applicable activities (excluding household occupations) ranged from 1.3 to 23.6 mg/m^3. The average of the six midpoints was 7.8 mg/m^3 (range 2.5 to 14.4). Average personal exposure while working range from 3.5 to 9.3 mg/m^3 (Molocznik and Zagorski 2000, p. 47 and 48).

Personal exposure to TSP during routine work in 85 dairy barns in Wisconsin averaged 1.78 mg/m^3 (geometric sd = 2.9). Area concentrations within barns averaged 0.74 mg/m^3 (geometric sd = 3.05) (Kullman et al. 1998, third page).

Personal exposure to TSP of bulldozer operators and other workers at three landfills in Ontario average 5.3 mg/m^3 and ranged from 0.44 to 22.8 mg/m^3. Only one measurement was greater than 10 mg/m^3 (Mozzon et al. 1987, p. 115).

Clausnitzer and Singer (1997) measured exposure to PM_4 during farming activities conducted in Davis California. Sampler inlets were placed directly on farm implements; therefore, dust concentrations may have been higher than those experienced by equipment operators if the inlets were located closer to the source of dust than operators or if operators were within enclosed cabs. Average (arithmetic) concentrations of respirable dust during 29 farming activities ranged from 0.2 to 13.6 mg/m^3. The average of those 29 activities was 2.9 mg/m^3. Eighteen of the activities had average concentrations of ≤ 2 mg/m^3. Only one activity (land planing, 13.6 mg/m^3) had an average concentration >10 mg/m^3, and four others had concentrations >5 mg/m^3 (Clausnitzer and Singer 1997, Table 1).

6.1.1.2 Parameter Distribution

The distribution recommended for use in the biosphere model must be representative of the average concentration experienced over a one-year period and it must be representative of the average of the lifestyle characteristics of the people in Amargosa Valley (see Section 6.0). Therefore, the distribution should not encompass extremely high or low values associated with activities that are conducted infrequently.

Typical dust-generating activities likely conducted by people while working in Amargosa Valley include field preparation, harvesting, and other activities required to grow field crops; livestock feeding and management; and excavating. Because most field crops grown in Amargosa Valley are perennials such as alfalfa and fruit and nut trees, disking, plowing, and other soil disturbing activities that generate very high concentrations of dust are not conducted frequently. People in Amargosa Valley would also generate dust while gardening, landscaping, riding horses, or participating in other recreational activities outdoors. There are no published measurements of particulate concentrations associated with these activities. Gardening and landscaping would generate less dust than the soil-disturbing agricultural activities included in the studies reviewed above because large mechanical equipment usually is not used.

Calculations of the total amount of dust inhaled by a receptor are sensitive to estimates of mass loading in the active outdoor environment (Appendix A), so a full range of average values that encompass uncertainty in this parameter must be included in the recommended distribution. There is uncertainty in the use of the studies reviewed above, associated primarily with the following three factors. First, the studies were conducted in environments that are different than the Yucca Mountain region. The studies by Nieuwenhuijsen et al. (1998, 1999) are most applicable because they were conducted in semi-arid conditions, and because fields there and in Amargosa Valley are irrigated. Second, the activities for which mass loading concentrations have been measured do not include all typical dust-generating activities conducted in Amargosa Valley. For example, there are no measurements associated with gardening and other outdoor recreational activities. Finally, there is no information on the relative amount of time people in Amargosa Valley spend conducting various dust-generating activities while in the active outdoor environment.

Based primarily on the results of Nieuwenhuijsen et al. (1999), a triangular distribution with a mode of 5 mg/m^3, minimum of 1 mg/m^3, and maximum of 10 mg/m^3 is selected. The mode is higher than the average of activities monitored by Nieuwenhuijsen et al. (1999), but lower than the average or midpoint of some of the other studies (Table 6.1.1-1). The one-order-of-magnitude range covers the majority of the values measured in the studies described above and therefore adequately encompasses the uncertainty associated with those studies.

6.1.2 Inactive Outdoor Environment

TSP concentrations measured at stationary, outdoor sites in arid to semi-arid, rural, agricultural settings in the western United States were used to develop a distribution of mass loading values for the inactive outdoor environment. These data were selected because measurements taken at stationary, outdoor sites are representative of mass loading concentrations that would be experienced by a person in a rural agricultural setting who is outdoors and not conducting activities that resuspend substantial amounts of dust.

6.1.2.1 Selection of Data

A database of average annual concentrations of TSP for the United States and territories for years 1970 through 2001 was obtained from the AirData database managed by the EPA Office of Air Quality and Standards (DTN MO0210SPATSP01.023, see Section 4.1.2). All correspondence and data files associated with this set of data are located in the Records Information System and can be accessed via the link on the Automatic Technical Data Information Form for this DTN in the Technical Data Management System. The data was obtained via e-mail, rather than from the EPA AirData internet database, because that internet database does not provide access to TSP data.

Two datasets received from the EPA were used in this analysis:

1. KR450TSP.TXT, obtained from the EPA on September 6, 2002 (Ambrose 2002a). This dataset contains 76,220 records. Each record includes an annual geometric mean concentration of TSP at a monitoring site.

2. KR380.NATION.TXT, obtained from the EPA on September 17, 2002 (Ambrose 2002b). This dataset contains 11,763 records. Each record contains site description information (e.g., address, setting, years active) for TSP monitoring sites.

Information from these two datasets were imported into an ACCESS database and parsed according to the report manual (AQ1.WPD) provided by the EPA (Ambrose 2002a). The two files were then merged by station number to create a database labeled COMBINEDTSP that contains all the TSP data (from KR450TSP.TXT) for each station as well as the site description data (from KR380.NATION.TXT).

The database COMBINEDTSP was then queried to obtain all records having a land use classification of agricultural (EPA code = 4), and a location setting of rural (EPA code = 3) for the following eight states: Arizona, California, Idaho, Nevada, New Mexico, Oregon, Utah, Washington. These states were selected to ensure that a large sample of analog sites with an arid or semi-arid climate similar to that predicted for Yucca Mountain in the future would be selected. The rural, agricultural location and land use classification were selected to match the setting and land use in Amargosa Valley. That query resulted in a list of 486 valid annual measurements. Fifty-nine of those measurements from sites located west of the Cascade Range in Oregon were eliminated from further consideration because the climate in that region is not arid or semi-arid. An additional 32 duplicate annual averages (included by EPA to present annual averages with and without unusually high 24-hour measurements) were deleted; the lower of the values for a year were deleted. The remaining 395 records for 68 sites are listed in Appendix B, Table B-1.

To identify which sites have an arid or semi-arid climate, representative data on average annual precipitation and snowfall were obtained for the 68 sites from NCDC (1998a, b) (Table B-2). Information for each site was then examined to select those that are appropriate analog sites for Amargosa Valley. Sites were deleted or selected for the following reasons.

- Two sites (35-006-0007 and 35-061-0007) were combined because they were in the same location but had different New Mexico county codes, resulting in a total of 67 sites.

- Ten sites were deleted because average annual precipitation exceeded 20 inches (Table B-2). The average TSP concentration of those sites was 0.036 mg/m^3 (sd = 0.009). An additional 11 sites were deleted because average annual snowfall exceeded 20 inches per year (0 concentration = 0.053 mg/m^3, sd = 0.026) (Table B-2). This was done to ensure that only sites with an arid or semi-arid climate representative of current and potential future climates at Yucca Mountain were included. Arid sites generally are considered to have less than about 10 inches of precipitation (Brady and Weil 1999, p. 830) and the semiarid future climate for the next 10,000 years is predicted to have a maximum precipitation of 16 to 18 inches (USGS 2001, Table 2; NCDC 1998b). The results of this analysis show little sensitivity to these cutoff values. The average TSP concentration for the 20 sites with <10 inches of precipitation (0 = 0.060 mg/m^3, sd = 0.036) was similar to that for 57 sites with <20 inches (0 = 0.056 mg/m^3, sd = 0.029), and to all 67 sites (0 = 0.053 mg/m^3, sd = 0.028). Likewise, the average concentration for the 42 sites with <10 inches of snowfall (0 = 0.056 mg/m^3, sd = 0.031) was similar to that for 52 sites with <20 inches (0 = 0.054 mg/m^3, sd = 0.030) and to all 67 sites (0 = 0.053 mg/m^3, sd = 0.028).

- Based on the site description information in the file KRNATIONRPT.WPD, one site (04-019-0009) was deleted because it was near an electrical power plant, and a second (04-013-0008) was deleted because it had abnormal readings "due to substantial updraft." These two sites had average TSP concentrations of 0.081 and 0.131 mg/m^3, respectively.

- Twenty-three sites were deleted because there was more than one monitoring site within a county (Table B-2). The average concentration at those sites was 0.051 mg/m^3 (sd = 0.035). For counties with more than one monitoring station, the site with the greatest number of years of data was selected. If sites within a county had the same number of years of data, the site with the highest average TSP was chosen (because a higher TSP will result in a higher predicted inhalation dose, see Equation 6-1).

The remaining 21 sites had an average TSP concentration of 0.057 mg/m^3 (sd = 0.019) (Table 6.1.2-1). The minimum and maximum annual average concentrations were 0.025 and 0.089 mg/m^3, respectively.

6.1.2.2 Parameter Distribution

The TSP concentrations in Table 6.1.2-1 do not appear to be symmetrically distributed because there are more values near the high end of the distribution (5 values from 0.078 to 0.089 mg/m^3) than at the low end (3 values from 0.025 to 0.036 mg/m^3). Therefore, a triangular distribution is selected for the nominal inactive outdoor environment, with a mode of 0.060 mg/m^3, minimum of 0.025 mg/m^3, and maximum of 0.100 mg/m^3. The mode and maximum are slightly higher than the average and maximum in Table 6.1.2-1 to account for the cluster of high values.

The modal value is much higher than concentrations measured at relatively undisturbed, non-agricultural sites at Yucca Mountain (minimum and maximum annual TSP concentrations = 0.019 and 0.030 mg/m^3, respectively [CRWMS M&O 1999b, Table 2-3]), which confirms that the measurements selected are influenced to some extent by dust-disturbing activities such as those encountered in agricultural settings, or by some other sources of resuspended particles.

Table 6.1.2-1. Average Concentration of TSP at 21 Selected Monitoring Sites[a]

EPA Site ID	State	City	County	0 TSP (mg/m^3)	N Years
04-007-1902	Arizona	Miami	Gila	0.030	8
04-019-0010	Arizona	Tuscon	Pima	0.089	2
06-013-1002	California	Bethel Island	Contra Costa	0.041	6
06-019-1002	California	Five Points	Fresno	0.078	13
06-027-0002	California	Bishop	Inyo	0.025	8
06-031-1002	California	Kettleman City	Kings	0.086	9
06-071-1101	California	Twentynine Palms	San Bernardino	0.049	11
06-083-1011	California	Jalama	Santa Barbara	0.045	7
06-111-3001	California	El Rio	Ventura	0.064	13
06-113-4001	California	Dunnigan	Yolo	0.044	13
32-003-1003	Nevada	Moapa	Clark	0.061	1
32-031-1004	Nevada	Sparks	Washoe	0.054	12
35-013-0004	New Mexico	Sunland Park	Dona Ana	0.080	17
35-017-0002	New Mexico	Hurley	Grant	0.085	3
35-045-0014	New Mexico	Kirtland	San Juan	0.044	14
35-061-0007	New Mexico	Bluewater	Cibola/Valencia	0.071	6
41-059-1001	Oregon	Pendelton	Umatilla	0.040	5
49-015-0002	Utah	Hunington	Emery	0.030	4
53-039-0002	Washington	Bingen	Klickitat	0.056	4
53-071-1001	Washington	Wallula Junction	Walla Walla	0.066	9
53-077-0003	Washington	Sunnyside	Yakima	0.062	10
			Average =	0.057	
			sd =	0.019	

Notes: DTN: MO0210SPATSP01.023

[a] See Appendix B for additional descriptions of these sites and annual average measurements.

This distribution adequately encompasses uncertainty and variation associated with dust concentrations in this environment for the following reasons. First, the distribution is based on a large set of data from a variety of applicable sites. Therefore, it encompasses variation associated with land use, climate, soil type, and other site specific conditions. Second, the distribution encompasses most annual average values from rural agricultural sites in that set of data. Of 426 annual average concentrations reported for rural agricultural sites in eight western states (range = 0.012 to 0.173 mg/m^3), only 18 were less than 0.025 mg/m^3 and 17 were greater than 0.100 mg/m^3. Third, calculations of the amount of dust inhaled in the biosphere model are not sensitive to changes in mass loading in the inactive outdoor environment (Appendix A).

6.1.3 Active Indoor Environment

A review of applicable literature (See Section 4.1.1) was conducted to identify applicable average concentrations of resuspended particles measured indoors while people were present and awake. The results are summarized in Table 6.1.3-1. Studies were considered applicable if measurements of indoor concentrations were taken while people were home and active or if personal exposure was measured while people were indoors and active. Because there are few public buildings in Amargosa Valley, and because a large portion of the population there does not work (Bureau of the Census 2002, Table P43), measurements taken in homes were considered more applicable than those taken in public buildings. Because concentrations of TSP were measured in only three of the studies reviewed, studies that measured PM_{10} were also included. For use in this analysis, PM_{10} concentrations must be converted to TSP, so applicable measurements of the ratio of TSP to PM_{10} also were reviewed.

For many of the following studies, both personal exposure and stationary indoor concentrations (i.e., measured using a stationary monitor placed in a central location in the house) were reported. Measurements of personal exposure are most applicable to this environment if the people monitored spent their time indoors conducting a variety of typical activities. Measurements of personal exposure during dust-generating activities (e.g., during housework and cooking) are useful for understanding maximum indoor concentrations, but are not representative of average concentrations while indoors. Static measurements are most applicable if they were taken while people were present and active. Outdoor concentrations measured at regional monitoring sites were also reported in most studies and are included here to compare general levels of dustiness outdoors during the studies to those expected in a rural, agricultural community (see Section 6.1.2).

The only source of indoor contaminated particulates for the biosphere model is soil or ash that is tracked or blown indoors. Other sources of indoor, airborne particles may have contributed substantially to mass load concentrations in some studies. For example, smoking resulted in a 37% increase in average daytime PM_{10} concentrations in homes in Riverside California (Clayton et al. 1993, Table 6) and concentrations in homes in Tucson with smokers were more than twice as high as those without (Quackenboss et al. 1989, Table 3). Cooking, use of household cleaning products, and other activities also generate resuspended particles that would not be contaminated in the scenarios considered in this analysis (e.g., Long et al. 2000, pp. 1242 to 1245). Therefore, the most applicable studies are those that omitted homes with smokers or that present data separately for homes with and without smokers.

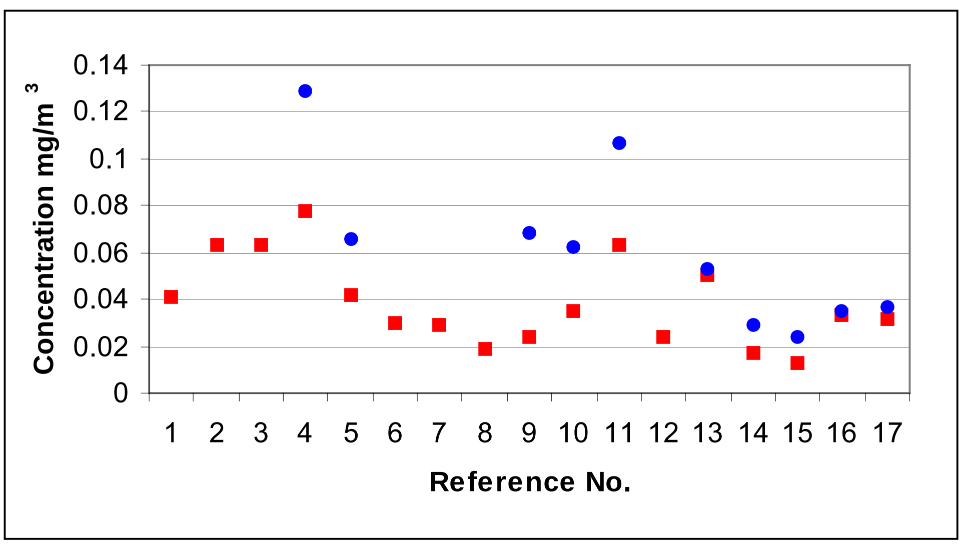
6.1.3.1 Literature Review

Indoor and Personal Exposure Concentrations—Wigzell et al. (2000) measured TSP and $PM_{2.5}$ concentrations over 48-hour periods in the kitchens and living rooms of 10 homes in Oxford England. Sampling devices in the living rooms were on only when residents were home. The average TSP concentration in living rooms was 0.041 mg/m^3 (range = 0.026 to 0.118). The average in nine homes where smoking did not occurr was 0.036 mg/m^3. Outdoor PM_{10} concentrations averaged 0.019 mg/m^3 (Wigzell et al. 2000, Table 3).

Thatcher and Layton (1995) measured TSP and PM_{10} concentrations in one home in California during normal and staged activities. The TSP concentration while five residents (2 adults and 3 children) were present "performing normal activities" was 0.063 mg/m^3. Outdoor PM_{10} concentrations at that time were 0.014 mg/m^3. In one experiment, TSP concentrations after vigorous cleaning was about 0.2 mg/m^3, and decreased to about 0.05 within 60 minutes. Walking into a room that previously had no activity caused concentrations of particles with an average aerodynamic diameter ≥5 μm to more than double. Cleaning caused an 11.4-times increase in the concentration of particles 5 to 10 μm and a 29.5-times increase in the concentration of particles ≥10 μm (Thatcher and Layton 1995, Table 3, Figures 3 and 7).

Table 6.1.3-1. Particulate Concentrations–Nominal Indoor Active Environment

		Personal Exposure, mg/m^3		Concentration Indoors, mg/m^3		
	Reference	**0**	**Range**	**0**	**Range**	**Comments**
1	Wigzell et al. 2000, Table 3			0.041	0.026-0.118	TSP, 10 homes, England
2	Thatcher and Layton 1995, Table 3			0.063		TSP, 1 home, California
3	Yocom et al. 1971, Table 1			0.063	0.049-0.076	TSP, 2 homes, Connecticut
4	Clayton et al. 1993, Table 2	0.129	0.060-0.263	0.078	0.031-0.181	PM_{10}, 178 people, California
5	Lioy et al. 1990, Figures 4, 5, 6	0.066	0.030-0.130	0.042	0.028-0.058	PM_{10}, 14 people, New Jersey
6	Quackenboss et al. 1989, Table 3			0.03	sd = 0.020	PM_{10}, 43 homes, Arizona
7	Leaderer et al. 1999, Table 1			0.029	0.005-0.098	PM_{10}, 49 homes, Connecticut and Virginia, summer, with A/C
8	Long et al. 2000, Table 2			0.019	0.003-0.095	PM_{10}, 9 homes, Massachusetts
9	Pellizzari et al. 1999, Figure 2	0.068	0.025-0.104	0.024	0.009-0.065	PM_{10}, 881 people, Toronto
10	Janssen et al. 1998, Table 1	0.062	0.038-0.113	0.034	0.019-0.065	PM_{10}, 37 people, Amsterdam
11	Brauer et al. 2000, Table 4	0.107	sd = 0.002	0.063	sd = 0.002	PM_{10}, 49 people, Slovakia, summer
12	Monn et al. 1997, Table 2			0.024	0.011-0.033	PM_{10}, 17 homes, Switzerland
13	Wheeler et al. 2000, Table 2	0.053		0.05		PM_{10}, 10 children, London
14	Howard-Reed et al. 2000, Table 2 Evans et al. 1999, Table 8	0.029	0.003-0.221	0.017	0.012-0.023	PM_{10}, 51 people, retirement facility, California
15	Howard-Reed et al. 2000, Table 2 Williams et al. 2000, Table 4	0.024	<0.001-0.249	0.013	0.007-0.030	PM_{10}, 21 people, retirement facility, Maryland
16	Linn et al. 1999, Table 2	0.035	0.005-0.085	0.033	0.009-0.105	PM_{10}, 30 people with lung disease, California
17	Rojas-Bracho et al. 2000, Table 2	0.037	0.009-0.211	0.032	0.002-0.329	PM_{10}, 18 people with pulmonary disease, Massachusetts



Studies 1 , 2, and 3 measured TSP, all others measured PM_{10}

Squares = average indoor concentrations, circles = average personal exposure concentrations

Yocom et al. (1971) measured TSP concentrations in two homes, two office buildings, and two public buildings over three seasons in Hartford Connecticut. The average daytime concentration in the homes was 0.063 mg/m^3 (range = 0.049 to 0.076). Average daytime concentrations in office and public buildings were 0.073 mg/m^3 (range = 0.057 to 0.087) and 0.046 mg/m^3 (range = 0.036 to 0.060), respectively. Outdoor concentrations in the area averaged 0.089 mg/m^3 (Yocom et al. 1971, Table 1).

Clayton et al. (1993) summarized the results of a study conducted by the EPA to estimate population levels of exposure to particulates in Riverside California. Indoor, outdoor, and personal exposure concentrations of PM_{10} were measured for a probability-based sample of 178 nonsmokers ≥10 years old. Daytime personal exposure averaged 0.129 mg/m^3 (10th and 90th percentiles = 0.060 and 0.263, respectively) (Clayton et al. 1993, Table 2). Nighttime personal exposure averaged 0.068 mg/m^3 (10th to 90th percentiles = 0.037 to 0.135). The people monitored spent an average of about 50% of their daytime hours out of their house; therefore, measurements of personal exposure may not be as applicable to this analysis as indoor measurements. Daytime and nighttime concentrations measured at a stationary indoor monitor averaged 0.078 mg/m^3 (0.031 to 0.181) and 0.053 mg/m^3 (0.025 to 0.117), respectively. Average indoor concentrations were 37% higher in homes on days when housework occurred (0.091 mg/m^3 compared to 0.057 mg/m^3 on days with no housework). The average indoor concentration (0.078 mg/m^3) is between those values and therefore appears to be a reasonable estimate of homes with and without substantial dust-generating activities. PM_{10} concentrations at outdoor, regional monitoring sites averaged 0.079 mg/m^3 (Clayton et al. 1993, Table 2).

Personal exposure to PM_{10} for 14 people in Phillipsburg, New Jersey, averaged 0.066 mg/m^3 (range approximately 0.030 to 0.130 mg/m^3). Most personal exposure concentrations were between 0.040 and 0.080. Concentrations inside fourteen homes averaged 0.042 mg/m^3 (range approximately 0.028 to 0.058 mg/m^3). Outdoor concentrations averaged 0.048 mg/m^3. There were no smokers living in the homes and all measurements lasted 24 hours (Lioy et al. 1990, Figures 4, 5, and 6).

PM_{10} concentrations in 43 homes in Tucson, Arizona, without smokers averaged 0.030 mg/m^3 (sd = 0.020, 24-hour measurements). Homes with evaporative coolers had lower concentrations (average = 0.021) than those without (average = 0.038). Homes with smokers had much higher concentrations (average = 0.075) (Quackenboss et al. 1989, Table 3). Outdoor concentrations were not reported.

PM_{10} concentrations during summer in 49 homes in Connecticut and Virginia with air conditioning was 0.029 mg/m^3 (range = 0.005 to 0.098, 24-hour measurements). Concentrations in 8 homes without air conditioning averaged 0.033 mg/m^3 (range = 0.018 to 0.60). Concentrations during winter in 84 homes without kerosene heaters averaged 0.026 mg/m3 (range = 0.003 to 0.182). Concentrations outside of homes averaged 0.028 and 0.024 mg/m3 during summer and winter, respectively (Leaderer et al. 1999, Tables 1 and 4).

Concentrations of PM_{10} in nine homes without smokers in Boston, Massachusetts, averaged 0.019 mg/m^3 (range = 0.003 to 0.095, 24-hour measurements). Peak concentrations during dusting and vigorous walking were 0.105 and 0.041 mg/m^3, respectively. Outdoor PM_{10}

concentrations averaged 0.013 mg/m^3, lower than other studies reviewed here (Long et al. 2000, Tables 2 and 3).

Personal exposure to PM_{10} in a stratified sample of the population in Toronto, Canada, averaged 0.068 mg/m^3 (10th and 90th percentiles approximately 0.025 and 0.104, 24-hour measurements). Indoor concentrations averaged 0.024 mg/m^3 (10th and 90th percentiles approximately 0.009 and 0.065). Outdoor concentrations averaged 0.024 mg/m^3 (Pellizzari et al. 1999, Figure 2).

Personal exposure to PM_{10} for 37 nonsmokers (50−70 years old) in Amsterdam, Netherlands, averaged 0.062 mg/m^3 (range = 0.038 to 0.113). Indoor exposure averaged 0.034 mg/m^3 (range = 0.019 to 0.065) and outdoor concentrations averaged 0.042 mg/m^3. On the days they were monitored, subjects spent an average of 1.3 hours outdoors and 20.5 hours at home; therefore, personal exposure concentrations reported here likely are a good measure of concentrations in the active indoor environment of this sample (Janssen et al. 1998, Table 1).

Brauer et al. (2000, Table 4) measured personal exposure and PM_{10} concentrations in homes of 18 office workers, 15 high school students, and 16 industrial workers in Slovakia. Personal exposure (24-hour) during summer and winter averaged 0.107 mg/m^3 (geometric sd = 0.002) and 0.105 mg/m^3 (geometric sd = 0.002), respectively. Twenty-four hour average concentrations in homes during summer and winter were 0.063 (geometric sd = 0.02) and 0.060 mg/m3 (geometric sd = 0.002), respectively. Outdoor PM_{10} concentrations averaged 0.033 and 0.040 mg/m^3 during summer and winter. Participants of this study spent an average of 71% of their time at home (Brauer et al. 2000, Table 1).

PM_{10} concentrations in 17 homes in Switzerland averaged 0.024 mg/m^3 (range 0.011 to 0.033). Homes where substantial activity occurred (home groups A and C) had average concentrations of 0.029 mg/m^3. Outdoor concentrations averaged 0.022 mg/m^3 (Monn et al. 1997, Table 2).

Personal exposure to PM_{10} for 10 children in London, England, during daytime averaged 0.053 mg/m^3 (no range presented). Concentrations in homes while children were present averaged 0.050; smokers were present in some homes. Average concentrations in gardens, classrooms, and at a regional outdoor monitoring site were 0.022, 0.079, and 0.024 mg/m^3, respectively (Wheeler et al. 2000; Table 2).

The lifestyles, physical conditions, and similarity between personal and indoor concentrations indicate that the subjects of the following studies were sedentary and therefore did not resuspend substantial concentrations of particles. These results therefore are applicable only for identifying a lower bound of a population estimate for Amargosa Valley.

Personal exposure to PM_{10} was measured in retirement facilities in Fresno, California, and Baltimore, Maryland. Average exposure while awake at home indoors was 0.029 (range = 0.003 to 0.221) and 0.024 mg/m^3 (range = <0.001 to 0.249) in Fresno and Baltimore, respectively (Howard-Reed et al. 2000, Table 2). Concentrations in apartments at the Fresno facility averaged 0.017 mg/m^3 (range = 0.012 to 0.023), and outdoor ambient concentrations there averaged 0.021 mg/m^3 (Evans et al. 1999, Table 8). Concentrations in apartments in Baltimore averaged 0.013 mg/m^3 (range = 0.007 to 0.030) and outdoor concentrations averaged 0.028 mg/m^3 (Williams et al. 2000; Table 4).

Personal exposure to PM_{10} for 30 people in Los Angeles, California, with severe lung disease averaged 0.035 mg/m^3 (range = 0.005 to 0.085). Concentrations in their homes averaged 0.033 mg/m^3 (range = 0.009 to 0.105). Outdoor concentrations averaged 0.033 mg/m^3 (Linn et al. 1999, Tables 1 and 2).

Personal exposure to PM_{10} for 18 people in Boston, Massachusetts, with chronic obstructive pulmonary disease averaged 0.037 mg/m^3 (range = 0.009 to 0.211, winter and summer, daytime measurements). Concentrations in their homes averaged 0.032 mg/m^3 (range = 0.002 to 0.329, 24-hour measurements). Outdoor concentrations averaged 0.022 mg/m^3 (Rojas-Bracho et al. 2000, Table 2).

TSP:PM_{10} Ratios—The following are summaries of applicable measurements of the ratio of TSP to PM_{10} and TSP:$PM_{2.5}$. The ratios measured by Brook et al. (1997) and at Yucca Mountain (Appendix E) were derived from stationary outdoor monitors and are not as applicable as ratios from the other studies, which were based on indoor measurements. However, results of the latter studies are useful for corroborating the other results.

Thatcher and Layton (1995, Table 3 and Figure 3) measured a TSP:PM_{10} ratio of 2.7:1 during normal indoor activities, 3.2:1 immediately after vigorous cleaning, and 1.6:1 one hour after cleaning had ended.

The ratio of TSP:PM_{10} in homes following the eruption of Mount St. Helens was 3:1 (Buist et al. 1986a, Table 2).

The average ratio of TSP to $PM_{2.5}$ measured in nine homes in England was 2.7:1 (Wigzell et al. 2000, Table 3, comparison of arithmetic mean of concentrations in living rooms). The TSP:PM_{10} ratio would have been lower because the concentration of fragments from 2.5 to 10 μm would be included in the denominator of the ratio.

Average TSP:PM10 ratios for 19 locations in Canada was 1.8–2.0:1. Tenth and 90th percentiles were 3.3:1 and 1:1. These measurements were taken at stationary outdoor monitors (Brook et al. 1997, Table 3).

The ratio of TSP to PM_{10} outdoors at Yucca Mountain averaged about 2.5. This value is based on 1,276 simultaneously collected measurements of TSP and PM_{10} taken during 1989 through 1997. This data and the associated DTNs are displayed in Appendix E. Twenty-four ratios of less or equal to 1.0 (i.e., PM_{10} concentrations the same as or higher than TSP) were omitted from consideration. Six of these ratios had PM_{10} values of zero and 15 others had very low values of TSP and PM_{10} (<10 μg/m^3) or very small differences between TSP and PM_{10} (≤2 μg/m^3). Thus, most of these incorrect ratios likely were the result of normal measurement error for the equipment used. The average TSP:PM_{10} ratio for the remaining 1,276 measurements was 2.49:1 (sd = 1.03). The median value was 2.22 and the ratios ranged from 1.0 to 12.57. The data were skewed toward small values; 84% of ratios were <4.0 and 94.3% were <5.0.

6.1.3.2 Parameter Distribution

Average personal exposure to PM_{10} ranged from 0.024 to 0.129 mg/m^3 and indoor concentrations ranged from 0.013 to 0.078 mg/m^3 (Table 6.1.3-1). These ranges likely include the true average concentration for the Amargosa Valley population because the studies reviewed were conducted over a variety of conditions, including some with relatively high outdoor concentrations (e.g., Clayton et al. 1993; Lioy et al. 1990), and because results did not vary much among studies. As shown in Appendix A, this range of variation and uncertainty will have a moderate influence on the amount of dust inhaled by a receptor.

A triangular distribution with a mode of 0.100 mg/m^3, minimum of 0.060 mg/m^3, and maximum of 0.175 mg/m^3 is selected for the active indoor environment. The minimum value is based on the three studies that measured TSP indoors (references 1, 2, and 3 in Table 6.1.3-1). The upper bound is based on a high PM_{10} concentration of 0.070 mg/m^3 and a TSP:PM_{10} ratio of 2.5:1. The PM_{10} concentration of 0.070 mg/m^3 is similar to the maximum average indoor concentrations measured in the studies reviewed (Table 6.1.3-1) and higher than all but two of the average personal exposure concentrations measured. The subjects of the two studies that had higher average levels of personal exposure (Clayton et al. 1993; Brauer et al. 2000) spent a substantial amount of time away from their homes and therefore may have been exposed to excess sources of particulates or to particulates that would not be contaminated in the biosphere analysis scenarios (e.g., car exhaust, industrial pollutants). The TSP:PM_{10} ratio is based on the range of 1.6:1 to 3:1 measured indoors in three studies, and confirmed by outdoor ratios. The modal value selected is less than the midpoint between the minimum and maximum because all three applicable measurements of TSP are at the minimum end of the distribution, which indicates that the true average for the Amargosa Valley population likely is closer to the minimum than the maximum value.

This selected distribution has an approximately three-fold range from a minimum of 0.060 mg/m^3 to a maximum of 0.175 mg/m^3. This is less than the approximately five-fold and six-fold ranges of values for personal exposure and indoor concentrations, respectively, in the literature reviewed (Table 6.1.3-1). The range of the average TSP concentration for the Amargosa Valley population is expected to be smaller because the highest literature values were based on people that spent a substantial amount of time out of the environment and the lowest were based on very sedentary people. Thus, the recommended distribution adequately encompasses the applicable uncertainty and variation associated with those studies.

6.1.4 Asleep Indoor Environment

A review of applicable literature (See Section 4.1.1) was conducted to determine the range of average concentrations of resuspended particles measured while people were asleep indoors. The results are summarized in Table 6.1.4-1. Studies were considered most applicable if concentrations were measured while people were sleeping. Studies were also considered applicable if indoor concentrations were measured while subjects were inactive or absent. Because most applicable studies measured concentrations of PM_{10}, a review of applicable TSP:PM_{10} ratios was also conducted.

6.1.4.1 Literature Review

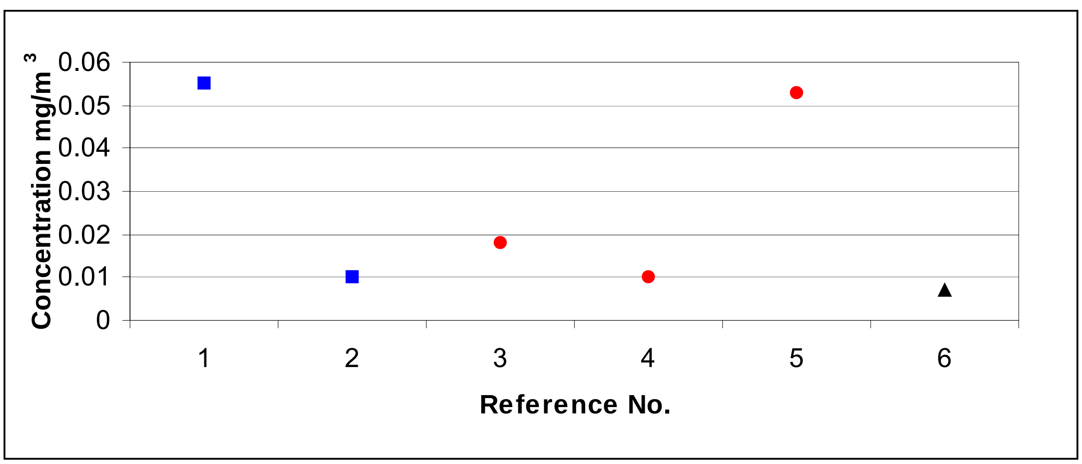
Thatcher and Layton (1995, Figure 3) reported a TSP concentration of about 0.055 mg/m^3 in a home in California one hour after all resuspension activities were stopped. The TSP:PM$_{10}$ ratio at that time was about 1.6:1. This measurement is analogous to one hour after people became inactive or went to bed.

Buist et al. (1983) measured personal TSP exposure concentrations of children ages 8 to 13 that were attending a summer camp in Oregon shortly after 1.2 cm of ash had fallen from the eruption of Mount St. Helens. Nighttime TSP concentrations were at or below the 0.01-mg/m^3 limit of detection of sampling equipment (Buist et al. 1983, p. 717). Although the results of this study are most applicable to analysis of the volcanic ash scenario, they are listed here to demonstrate that dust concentrations in the asleep indoor environment can be very low even when conditions outdoors are very dusty.

PM$_{10}$ concentrations in retirement apartments in Fresno, California, and Baltimore, Maryland, while residents were asleep averaged 0.018 mg/m^3 (range = 0.005 to 0.040) and 0.010 mg/m^3 (range = 0.001 to 0.159) (Howard-Reed et al. 2000, Table 2). Concentrations varied little while residents were asleep (Howard-Reed et al. 2000, Figures 1 and 2).

Table 6.1.4-1. Particulate Concentrations–Nominal Indoor Asleep Environment

	Reference	Concentration, mg/m^3		Comments
		0	Range	
1	Thatcher and Layton 1995, Figure 3	0.055		TSP, one hour after activities stopped, California
2	Buist et al. 1983, p. 717	<0.01		TSP, summer camp, Oregon, while sleeping
3	Howard-Reed et al. 2000, Table 2	0.018	0.005-0.040	PM$_{10}$, retirement facility, California, while sleeping
4	Howard-Reed et al. 2000, Table 2	0.010	0.001-0.159	PM$_{10}$, retirement facility, Maryland, while sleeping
5	Clayton et al. 1993, Table 2	0.053	0.025-0.117	PM$_{10}$, 178 people, California, 12-hr measurements
6	Long et al. 2001, Table 2	0.007	0.001-0.021	PM$_{2.5}$, nine homes, Boston, while sleeping



Squares = TSP, circles = PM$_{10}$, triangle = PM$_{2.5}$.

Indoor concentrations of PM_{10} at night (7:00 pm to 7:00 am) in homes of 178 people monitored in Riverside, California averaged 0.053 mg/m^3 (10th and 90th percentiles = 0.025 and 0.117) (Clayton et al. 1993, Table 2). These measurements probably are overestimates of concentrations of soil particles experienced while subjects were sleeping for two reasons. First, the measurement period includes times when people where active during the evening and early morning. Second, a portion of the mass load concentration consists of particles that would not be contaminated in the groundwater or volcanic ash scenarios. Yakovleva et al. (1999, Figure 7) examined the source contributions in this study and concluded that about 40 to 50% of particulate concentrations at night were from motor vehicles and secondary sulfates.

Long et al. (2001) measured $PM_{2.5}$ concentrations and volume of $PM_{2.5}$ and PM_{10} particles in nine homes of nonsmokers in Boston at night while people were asleep and/or inactive. The average $PM_{2.5}$ concentration was 0.007 mg/m^3 (5th and 95th percentiles = <0.001 to 0.021). Less than 10% of the particle volume consisted of particles 2.5 to 10 μm in diameter (Long et al. 2001; Table 2). Because few of the resuspended particles were larger than 2.5 μm, concentrations measured during this study are comparable to PM_{10} concentrations reported in other studies.

6.1.4.2 Parameter Distribution

A triangular distribution with a mode of 0.030 mg/m^3, minimum of 0.010 mg/m^3, and maximum of 0.050 mg/m^3 is selected for the asleep indoor environment. The minimum and maximum are based on the two measurements of TSP concentrations reported (Table 6.1.4-1). All but one applicable measurement of PM_{10} and $PM_{2.5}$ (Table 6.1.4-1), if multiplied by a TSP:PM_{10} ratio of 1.6:1 (from Thatcher and Layton 1995, Figure 3), are within this range. As discussed above, the average value of 0.053 mg/m^3 measured by Clayton et al. (1993) likely is an overestimate of applicable concentrations by a factor of at least two because it includes secondary vsulfates and particles generated by motor vehicles (Yakovleva et al. 1999). Thus, this distribution encompasses the range of variation and uncertainty in measurements of mass loads in the indoor asleep environment. As shown in Appendix A, estimates of the amount of dust inhaled are relatively insensitive to changes in dust concentrations in the indoor asleep environment.

6.1.5 Mass Loading—Crops

No measurements have been taken of mass loading near crops so it is assumed that the distribution of mass loading in fields and gardens where crops are growing is similar to or higher than that in the inactive outdoor environment, with a minimum value equal to the minimum value of the inactive outdoor environment, and a modal and maximum value twice that of the inactive outdoor environment. See Section 5.1 for justification of this assumption.

The distribution of mass loading in the inactive outdoor environment is triangular with a mode of 0.060 mg/m^3, and a range of 0.025 to 0.100 mg/m^3. Based on the above assumption, the distribution of mass loading for crops is predicted to have a mode of 0.120 mg/m^3, and a range of 0.025 to 0.200 mg/m^3.

6.2 MASS LOADING – VOLCANIC ERUPTION SCENARIO

This section describes the development of mass loading distributions within the five environments (four receptor environments and the environment around crops) for the volcanic ash exposure scenario. The representative biosphere for this scenario is the same as for the groundwater scenario: a rural community in an arid to semi-arid environment with conditions similar to those in the Yucca Mountain region and a population with lifestyle characteristics similar to those in the Town of Amargosa Valley today (based on requirements in 10 CFR 63, Sections 305 and 312, see Section 4.3). However, the source of radionuclides differs. For the volcanic ash scenario, the source of radionuclides is contaminated ash from a volcanic eruption at Yucca Mountain. Under normal, variable wind conditions, the initial, predicted thickness of the tephra deposit 20 km south of Yucca Mountain, calculated for the *Total System Performance Assessment for the Site Recommendation* (CRWMS M&O 2000, Section 3.10.5.1), ranged from less than 1×10^{-8} cm to about 10 cm. About 66 percent of predicted depths were less than 0.1 mm, about 80 percent were less than 1 mm, and about 95 percent were less than 1 cm. The location of the receptor considered for the TSPA analysis in support of a license application may differ from that used for the site recommendation (based on requirements in 10 CFR 63.302). Thus, ash thickness at the receptor location may be slightly different than that reported in the *Total System Performance Assessment for the Site Recommendation (*CRMWS M&O 2000, Section 3.10.5.1).

Initially, the tephra would be more readily suspendable than the soil upon which it was deposited, which would result in higher mass loading concentrations than experienced under nominal conditions (i.e., prior to the eruption). Through time the ash would erode, become mixed into the soil, become buried, or otherwise become stabilized. That erosion or stabilization would result in a decrease in mass loading, with concentrations eventually returning to conditions similar to those considered in the groundwater scenario (i.e., nominal concentrations). Because of this change in mass loading through time, dose resulting from a volcanic eruption must be calculated as a function of time, as described in the following equation (BSC 2003a, Section 6.5.8).

$$D_{all,i}(d_a,t) = D_{all,i} + D_{inh,p,i} f(d_a) + D_{inh,v,i}\, f(d_a) f(t) \qquad \text{Eq. 6.2-1}$$

where:

$D_{all,i}(d_a,t)$ = All-pathway annual dose from internal and external exposure to radionuclide i for an ash deposition thickness d_a at time t following a volcanic eruption (Sv/year).

$D_{all,i}$ = Annual dose from external exposure, radon inhalation, and ingestion of radionuclide i following a volcanic eruption (Sv/year).

$D_{inh,p,i}$ = Annual dose from inhalation exposure to radionuclide i resulting from exposure to nominal (p) mass loading following a volcanic eruption (Sv/year).

$D_{inh,v,i}$ = Annual dose from inhalation exposure to radionuclide i resulting from exposure to elevated, post-volcanic (v) mass loading in addition to nominal concentrations (Sv/year).

d_a = Thickness of the contaminated ash/soil layer (meters).

t = Time (year).

Three sets of BDCFs are required by this model, as shown in equation 6.2-2 (BSC 2003a, Section 6.5.8).

$$BDCF_i(d_a,t) = BDCF_i + \left(BDCF_{inh,v,i} f(t) + BDCF_{inh,p,i}\right) f(d_a) \qquad \text{Eq. 6.2-2}$$

where:

$BDCF_i(d_a,t)$ = BDCF of radionuclide *i* for an ash deposition depth d_a at time *t* following a volcanic eruption (Sv/y per Bq/m^2).

$BDCF_i$ = BDCF of radionuclide *i* for external exposure, radon inhalation, and ingestion following a volcanic eruption (Sv/y per Bq/m^2).

$BDCF_{inh,p,i}$ = BDCF of radionuclide *i* for inhalation of resuspended particles at nominal mass loading following a volcanic eruption (Sv/y per Bq/m^2).

$BDCF_{inh,v,i}$ = BDCF of radionuclide *i* for inhalation of resuspended particles at concentrations in addition to nominal mass loading following a volcanic eruption (Sv/y per Bq/m^2).

The set $BDCF_i$ includes the consequences of all exposure pathways except inhalation. This set of BDCFs is not a function of time or ash depth. The parameter mass loading for crops is not treated as a function of time in the volcanic ash scenario because it is used in the calculation of the ingestion dose. Therefore, the equation in the biosphere model for the volcanic ash scenario that uses mass loading for crops is the same as that described in Section 6.

$BDCF_{inh,p,i}$ includes the consequences of inhalation of resuspended particles at concentrations to be expected at some time following a volcanic eruption when mass loading has stabilized. Because concentrations of resuspended particles at that time will be influenced by the same factors considered when developing distributions for nominal conditions, the mass loading distributions for receptor environments developed in Section 6.1 are intended for use in calculating $BDCF_{inh,p,i}$. This set of BDCFs is a function of ash depth (because the dose contribution may change as ash depth decreases), but is not a function of time.

The set $BDCF_{inh,v,i}$ includes the additional dose contribution resulting from inhalation of elevated concentrations of resuspended contaminants following a volcanic eruption. This set contributes to the total dose (i.e., is greater than zero) only for the period starting at the end of the volcanic eruption (i.e., time = t_0, which starts after the initial ashfall has ceased) and ending when the ash blanket has eroded or stabilized and airborne concentrations are equal to predisturbance, nominal conditions. Concentrations of resuspended particles change during this period, and therefore the total mass loading in receptor environments following a volcanic eruption must be calculated as a function of time, as shown in the following equation (BSC 2003a, Section 6.5.2).

$$S_n(t) = S_n + S_{v,n} f(t) \qquad \text{Eq. 6.2.-3}$$

where:

$S_n(t)$ = Total average annual mass loading in receptor environment n at time t following a volcanic eruption (mg/m^3).

S_n = Nominal average annual mass loading in receptor environment n (mg/m^3)

$S_{v,n}$ = Elevated, post-volcanic (v) average annual mass loading in receptor environment n (i.e., in addition to or greater than $S_{v,n}$) during the first year (i.e., $t = 0$) following a volcanic eruption (mg/m^3).

$f(t)$ = Mass loading time function, which describes the rate of change in mass loading after a volcanic eruption.

The distributions of elevated mass loading concentrations, $S_{v,n}$ are developed in the remainder of this section. Because $S_{v,n}$ is combined with S_n to calculate the total mass loading in receptor environments following a volcanic eruption, $S_{v,n}$ represents only the additional concentrations of resuspended ash/dust in excess of nominal conditions during the first year following an eruption at Yucca Mountain. Because mass loading for crops is not treated as a function of time, that parameter distribution is representative of the entire concentration of resuspended particles following a volcanic eruption. The mass loading time function is developed in Section 6.3.

6.2.1 Active Outdoor Environment

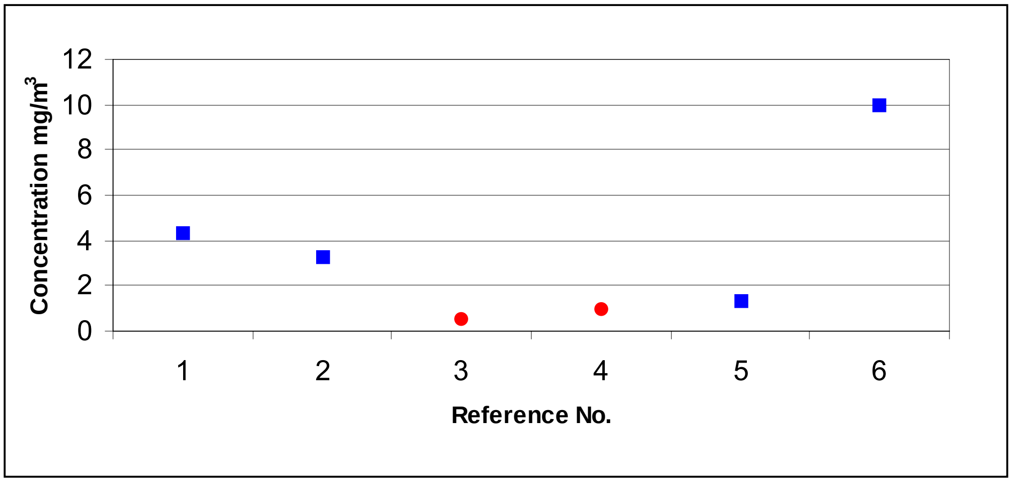
A review of applicable literature (See Section 4.1.1) was conducted to identify the magnitude of change in mass loading following the deposition of ash the first year following a volcanic eruption. Studies were considered applicable if personal exposure to TSP or PM_{10} were measured during dust-disturbing activities, or ambient TSP concentrations were measured during dust-disturbing activities, in areas having a relatively recent tephra deposit (i.e., less than about five years old). Summary values for each study reviewed are presented in Table 6.2.1-1.

6.2.1.1 Literature Review

Buist et al. (1986a, Table 2) report personal exposure to TSP for numerous occupations during the weeks following the eruption of Mount St. Helens. Many of the people monitored were involved in cleanup and removal of ash. Average concentrations were 2.65 mg/m^3 (range = 0.64–6.46) for hand-shoveling and sweeping, 5.50 mg/m^3 (range = 0.60–23.1) for sweeper-truck and broom-truck drivers, 5.96 mg/m^3 (range = 0.01–31.9) for grader operators, 1.48 mg/m^3 (0.23–6.14) for water-truck drivers, 9.01 mg/m^3 (range = 0.73–25.5) for rubbish workers, 1.42 mg/m^3 (range = 0.79–3.20) for agricultural workers, and 0.57 mg/m^3 (range = 0.04–4.17) for law enforcement personnel. The average of all occupational averages except law enforcement (excluded because law enforcement personnel may not have been conducting activities that resuspend ash) is 4.34 mg/m^3.

Table 6.2.1-1. Particulate Concentrations–Post Volcanic Active Outdoor Environment

	Reference	Concentration, mg/m^3		Comments
		0	Range	
1	Buist et al. 1986a, Table 2	4.34	1.48-9.01	TSP, dusty occupations, weeks following Mount St. Helens
2	Merchant et al. 1982, Table 6	3.28	0.13-8.31	TSP, loggers, weeks following Mount St. Helens
3	Searl et al. 2002, Table 11	0.5	0.2-10	PM_{10}, during eruptive phase of Soufriere Hills
4	Baxter et al. 1999, Figure 3	1	0.3-2.5	PM_{10}, during eruptive phase of Soufriere Hills
5	Buist et al. 1983, p. 717	1.35	1.24-1.46	TSP, children at summer camp, includes all daytime activities. Average of 2 sessions.
6	Hill and Connor 2000, p. 71	10	1-10	TSP while driving and walking, 4 years after Cerro Negro (note that data are not published)



Squares = TSP, circles = PM_{10}

Merchant et al. (1982, Table 6) compared personal exposure to TSP between loggers working in an area in Washington covered by ash from Mount St. Helens and loggers working in Oregon where there was no ash. See Buist et al. (1986b, Figure 6) for the location of study sites. Average TSP concentrations (and geometric sd) for Washington were 5.97 mg/m^3 (2.95) for cutters, 8.31 mg/m^3 (5.50) for choker setters, 0.49 for one truck driver, 0.13 mg/m^3 (3.84) for yarder and loader operators, and 1.52 mg/m^3 (5.24) for landing men. The average of these five occupations was 3.28 mg/m^3. Average concentrations for cutters in Washington were about twice those of cutters in Oregon (0 = 2.81 mg/m^3, sd = 1.46), but concentrations for yarder/loader operators (0 = 0.17 mg/m^3, sd = 1.04) were similar.

Searl et al. (2002) measured ambient concentrations and personal exposure to PM_4 and PM_{10} on the island of Montserrat in the British West Indies during 1996–2000. The Soufriere Hills volcano erupted periodically during much of this study, and was most active during 1996 through mid-1998. Measurements were taken throughout the island, including on the southern portion, where the tephra deposit was 5 to more than 30 cm thick (these areas were evacuated during 1996–1997 in part because of concerns about high concentrations of airborne particles), and to the north, where the ash was less than 1 to 5 cm thick. Average personal exposure to PM_4 during 1997 was 0.825 mg/m^3 (range = 0.817–0.833) for gardeners, >20 mg/m^3 (range = 0.077 to 71) for road workers, and 0.442 mg/m^3 for a housekeeper (Searl et al. 2002, Table 7). Concentrations of PM_{10} associated with mowing grass and sweeping inside were of the order of 10 to 20 mg/m^3. During 2000, personal exposure by those groups was considerably lower: 0.134 mg/m^3 (range = 0.007 to 0.444) for gardeners and 0.050 mg/m^3 (range = 0.012 to 0.105) for housekeepers (Searl et al. 2002, Table 8). Personal exposure to PM_{10} by children at school during 2000 was estimated to be 0.144 mg/m^3 while playing outdoors, 0.098 to 0.155 mg/m^3 while indoors, and 0.272 mg/m^3 while sweeping (Searl et al. 2002, Table 9). To model population exposure, the authors estimated average personal exposure to PM_{10} during various activities and for four levels of ash (Searl et al. 2002, Table 11). The low ash and raised ash concentrations appear to be most appropriate for this analysis, because alert and very high levels occurred during less than five percent of days on the northern and middle (i.e., Salem) portions of the island (Searl et al. 2002, Table 6). The very high and alert concentrations appear to correspond to days when the Soufriere Hills volcano was erupting and the wind was blowing ash toward a community. Estimated concentrations of PM_{10} during dusty work were 0.2 to 0.5 mg/m^3 for low and raised ash conditions, and 5 to 10 mg/m^3 for very high and alert concentrations. Estimated concentrations for outdoor play were 0.1 to 0.5 mg/m^3 for low and raised ash conditions, and 5 to 10 mg/m^3 for very high and alert conditions. Estimates for "active outside" were 0.05 to 0.2 mg/m^3 and 1 to 3 mg/m^3 for low to raised and very high to alert levels, respectively. A summary value of 0.5 mg/m^3, based on the estimate for dusty work during raised ash conditions, and a range of 0.2 to 10 mg/m^3 (also based on dusty work) is presented in Table 6.2.1-1 for this study. Assuming a TSP:PM_{10} ratio of about 10:1 (e.g., Nieuwenhuijsen et al. 1998, Table 2), an approximate TSP concentration for dusty work during this study is about 5 mg/m^3, with a range of about 2 to 100 mg/m^3.

Baxter et al. 1999 (Figure 3) reported concentrations of PM_{10} at two outdoor settings during an eruptive phase of the Soufriere Hills volcano. Peak concentrations during human activity were about 0.5–1.5 mg/m^3 outside at a primary school and 0.3 to 2.5 at a resort. A summary value of 1 mg/m^3 is presented in Table 6.2.1-1 for this report; this value is the approximate midpoint between low and high peak concentrations.

Buist et al. (1983) measured personal exposure to TSP during the summer of 1980 among children ages 8 to 13 at a summer camp where about 1.2 cm of ash had fallen after the June 12 eruption of Mount St. Helens. Daytime personal exposure averaged 1.24 mg/m^3 and 1.46 mg/m^3 during two sessions (Buist et al. 1983, p. 717). No information was presented on the percentage of time the children were active; therefore, these values likely underestimate exposure in the active outdoor environment.

The following information, which is not listed as an input in Section 4.1.1 (because it has not yet been published in a peer-reviewed journal), is included here to corroborate results of the other studies. Concentrations of TSP were measured in 1999 above the tephra deposit from the 1995 eruption of the basaltic volcano Cerro Negro in Nicaragua. Concentrations during light activity such as walking were on the order of 1 mg/m^3, and concentrations while driving over the tephra deposits in an open truck were on the order of 10 mg/m^3 (Hill and Connor 2000, p. 71).

6.2.1.2 Parameter Distribution

The measurements of personal exposure during outdoor, dust-generating activities on tephra deposits (Table 6.2.1-1) are similar to measurements taken under nominal conditions in areas without tephra (Table 6.1.1-1), except that most maximum post-volcanic measurements are lower than those from nominal conditions. For example, TSP concentrations for agricultural workers after the eruption of Mount St. Helens (0 = 1.42 mg/m^3, Buist et al. 1986a, Table 2) generally were lower than those reported by Nieuwenhuijsen et al. (1998, Table 2), although the distribution of all activities reported by Buist et al. is not substantially different from that of Nieuwenhuijsen et al. In the only study where a comparison was made of personal exposure in areas with and without ash, average respirable and total dust concentrations were about twice as high or less for various groups of loggers in areas with and without ash (Merchant et al. 1982, Table 6). Measurements of mass loading over disturbed tephra deposits probably are similar to those over other soil because most soils contain a reservoir of particles that are readily suspended when disturbed. Because measurements for nominal and post-volcanic conditions are very similar, and because there is a high probability that the initial tephra deposit south of Yucca Mountain will be very shallow (CRWMS M&O 2000, Section 3.10.5.1), a lower bound of a distribution of mass loading in the post-volcanic, active outdoor environment of 1 mg/m^3 is selected, the same as that for nominal conditions.

The maximum post-volcanic concentrations in Table 6.2.1-1 probably are lower than those reported for nominal conditions (Table 6.1.1-1) because few measurements have been taken on tephra deposits for the types of activities that create very large concentrations of mass loading, such as farming (although see Buist et al. 1986a, Table 2). In addition, none of the values presented above except those of Hill and Connor (2000) are from basaltic tephra deposits like those predicted to occur at Yucca Mountain (see Section 6.3.3 for a discussion of this uncertainty). Therefore, there is some uncertainty about the upper bound of this distribution. To account for that uncertainty, a mode of 7.5 mg/m^3 and maximum upper bound of 15 mg/m^3 are selected, 50% greater than that selected for nominal conditions.

For use in equation 6.2-3, mass loading distributions for the first year following a volcanic eruption, $S_{v,n}$ must be presented as the expected average annual increase in concentrations of resuspended particles that is greater than nominal concentrations. Thus, the recommended distribution of mass loading for S_v in the active outdoor environment is triangular, with a mode of 2.5, minimum of zero (i.e., equal to the minimum mass loading predicted for nominal conditions), and maximum of 5 mg/m^3.

6.2.2 Inactive Outdoor Environment

Measurements of TSP before and after the eruption of Mount St. Helens were analyzed to evaluate changes in the inactive outdoor environment before and after a volcanic eruption. A literature review also was conducted to confirm the results of data analysis.

6.2.2.1 Data Analysis

A dataset containing 24-hour concentrations of TSP measured in the state of Washington during 1979 through 1992 was obtained from the EPA Office of Air Quality and Standards (DTN MO0008SPATSP00.013). The dataset was sorted by date and concentration, and values for the period May 18 to July 31, 1980, (the ten-week period during which the four largest eruptions occurred, Sarna-Wojcicki et al. 1982, Figure 350) were examined to identify monitoring sites where large increases in TSP were measured following the eruption of Mount St. Helens. Thirteen sites in six cities were identified that had at least one 24-hour concentration greater than

0.4 mg/m^3. A value of 0.4 mg/m^3 was chosen as representative of a large increase because it is substantially higher than most other concentrations in this dataset. The thickness of the tephra deposit at these cities ranged from about 0.5 to about 10 mm (Sarna-Wojcicki et al. 1982, Figures 336, 344, 345, and 346). Clarkston had about 0.5 mm deposited on May 18, and Richland had 0.5−1 mm deposited on that date. Longview had 1−2 mm deposited on May 25 and <1 mm on June 12. Vancouver had <1 mm deposited on May 25 and 4−5 mm deposited on June 12. Spokane had 2.5−5 mm deposited on June 12, and Yakima had 5-10 mm on that date (Sarna-Wojcicki et al. 1982, Figures 336, 344, and 345).

For this analysis, one site was selected from each city. For all cities except Vancouver, data from the monitoring site with the highest reading during May 18 to July 31, 1980 were selected. Data from the Vancouver site with the second highest reading were selected because data from May 28 through September 5, 1980 were missing for the site with the highest concentration. The only monitoring station in Clarkston was established in September 1979. Measurements from the six sites are listed in Appendix D.

Average concentrations for the six sites were calculated for the periods March 1979−February 1980, June 1980−May 1981, and June 1981−May 1982 (Table 6.2.2-1). The first period ends prior to initial volcanic activity in March 1980, and the second period starts about 2 weeks after the major eruption on May 18; thus, these three periods represent average annual TSP concentrations the year before and the two years following the major eruption.

Changes in concentrations the year following the eruption appear to have been influenced by ash thickness (Table 6.2.2-1). Average annual concentrations and standard deviations at the two sites with <1 mm of ash (Clarkston and Richland) were lower or only slightly higher than concentrations the year prior to the eruption. Concentrations at the other four sites were about 40 to 90 percent higher, and variation was about two to three times, the year following the eruption. Average concentrations and standard deviations the second year after the eruption were very similar to those prior to the eruption at all sites (Table 6.2.2-1).

Based on this analysis, it was concluded that, in areas having <1 to 10 mm of ash from the eruption of Mount St. Helens, average concentrations of TSP were no more than two times higher the year following the eruption, but returned to pre-eruption levels the following year.

6.2.2.2 Literature Review

Information about concentrations of resuspended particles during and after eruptions of two additional volcanoes was reviewed to evaluate whether the analysis of data collected following the eruption of Mount St. Helens produced reasonable conclusions.

Gordian et al. (1996) examined the association between PM_{10} levels and daily outpatient visits in Anchorage, Alaska, after about 3 mm of ash were deposited from the August 1992 eruption of Mt. Spurr (McGimsey et al. 2001, p. 4). During the three months prior to the eruption, PM_{10} concentrations in Anchorage ranged from about 0.010 to 0.080 mg/m^3 (Gordian et al. 1996, Figure 1). The peak one-hour concentrations during the eruption was 3 mg/m^3 and the 24-hour

Table 6.2.2-1. Average Concentrations of TSP (mg/m^3) at Six Sites in Washington Before (Mar 79–Feb 80), One Year After (Jun 80–May 81), and Two Years After (Jun 81–May 82) the Eruption of Mount St. Helens.[a]

Site (EPA site #) and ash depth[b] Dates	0	sd	Minimum	Maximum	n[c]
Clarkston (53-003-0003) 0.5 mm ash					
Mar 79 – Feb 80	0.091	0.044	0.023	0.221	49
Jun 80 - May 81	0.107	0.058	0.048	0.388	76
Jun 81 - May 82	0.084	0.029	0.051	0.168	54
Richland (53-005-1001) 0.5–1.0 mm ash					
Mar 79 - Feb 80	0.069	0.057	0.005	0.333	60
Jun 80 - May 81	0.063	0.040	0.009	0.181	60
Jun 81 - May 82	0.050	0.028	0.011	0.111	59
Longview (52-015-0008) 1–3 mm ash					
Mar 79 - Feb 80	0.054	0.041	0.008	0.222	57
Jun 80 - May 81	0.097	0.141	0.021	0.986	56
Jun 81 - May 82	0.054	0.030	0.018	0.161	56
Spokane (53-063-0016) 2.5–5 mm ash					
Mar 79 - Feb 80	0.165	0.093	0.028	0.375	57
Jun 80 - May 81	0.226	0.155	0.024	0.743	59
Jun 81 - May 82	0.168	0.131	0.029	0.846	55
Vancouver (53-11-0006) 4–5 mm ash					
Mar 79 - Feb 80	0.050	0.030	0.005	0.158	61
Jun 80 - May 81	0.076	0.075	0.014	0.474	61
Jun 81 - May 82	0.055	0.029	0.014	0.124	61
Yakima (53-077-1006) 5–10 mm ash					
Mar 79 - Feb 80	0.060	0.041	0.011	0.259	59
Jun 80 - May 81	0.116	0.089	0.014	0.426	60
Jun 81 - May 82	0.061	0.046	0.012	0.339	61

Notes: DTN: MO008SPATSP00.013
[a] See Appendix D for the daily concentrations upon which these values were based.
[b] Initial ash depth, from Sarna-Wojcicki et al. 1982, Figures 336, 344, 345, and 346.
c Number of 24-hour measurements.

average concentration the day after the eruption was 0.565 mg/m^3 (Gordian et al. 1996, p. 290).Concentrations returned to pre-eruption levels after about three months, although there were occasional peaks of 0.1–0.2 mg/m^3 for about nine months. By May 1993, PM_{10} concentrations had returned to pre-eruption levels. Gordian et al. (1996, p. 293) concluded that PM_{10} concentrations in Anchorage were influenced by the volcano during August 18 through December 31, 1992. Average PM_{10} concentrations during that period were about 0.70 mg/m^3, less than twice the average concentration of 0.40 mg/m^3 during periods not influenced by the eruption (May 1, 1992–August 17, 1992 and January 1, 1993–March 1, 1994).

Yano et al. (1990) compared TSP concentrations in the city of Kanoya, Japan, with those of Tahiro. Kanoya is 25 km from Mount Sakurajima and in the region that experiences the highest exposure to ash from that volcano, which "erupts hundreds of times each year" (Yano et al.

1990, p. 368). Tashiro is 50 km from the volcano and outside of the affected area, and is similar to Kanoya in size and industrial development. Monthly average TSP concentrations (calculated as the sum of suspended particulate matter and nonrespirable particulates in Table 1 of Yano et al.) during summer 1995 were about twice as high in Kayona (0.030 mg/m^3) than in Tashiro (0.013 mg/m^3). Winter concentrations were about three times greater in Kayona (0.596 mg/m^3) compared to Tashiro (0.196 mg/m^3).

6.2.2.3 Parameter Distribution

Average ambient outdoor concentrations of TSP no more than doubled the year following the 1980 eruption of Mount St. Helens, and returned to pre-eruption levels the second year. This information is analogous to most climatic conditions and the thickness of the tephra deposit predicted for the area south of Yucca Mountain. Four of the six cities included in this analysis are in eastern Washington and have a climate similar to that predicted for Yucca Mountain for much of the next 10,000 years (USGS 2001, p. 67 and 74) (Clarkston [0 annual precipitation = 16.5 inches, 0 annual snowfall = 15.1 inches], Richland [0 precipitation = 7.0 inches, 0 snowfall = 10.2 inches], Spokane [0 precipitation = 16.2 inches, 0 snowfall = 42.14 inches], and Yakima [0 precipitation = 8.25 inches, 0 snowfall = 23.4 inches], NCDC 1998b). Therefore, the influence of precipitation and vegetation on consolidation and removal of ash at those sites following Mount St. Helens likely would be similar to that after an eruption at Yucca Mountain. Also, ash thickness at the four sites examined (1 to 10 mm) was as high or higher than about 95 percent of predicated ash depths 20 km south of Yucca Mountain (CRWMS M&O 2000, Section 3.10.5.1). Information from two other volcanoes confirm that average annual ambient concentrations of TSP are about twice as high the year following an eruption compared to pre-eruption levels or to similar areas without ash. Therefore, a triangular distribution with a mode of 0.120 mg/m^3 and a lower bound of 0.050 mg/m^3 are selected for the post-volcanic, inactive outdoor environment, twice that selected for nominal conditions.

None of the data analyzed or studies reviewed above were from areas that had tephra deposits as thick as the maximum of about 10 cm predicted for 20 km south of Yucca Mountain (CRWMS M&O 2000, Section 3.10.5.1). Because the thickness of the initial tephra blanket may influence mass loading the year following deposition, there is some uncertainty about the upper end of the distribution for the inactive outdoor environment. In addition, there is uncertainty about the influence of redistribution of ash from aeolian and fluvial processes on mass loading. For example, if heavy rains occur the first year after an eruption, additional ash particles may be carried through Fortymile Wash into the region south of Yucca Mountain, causing a temporary increase in mass loading within and near that wash (see Section 6.3 for additional information). To account for this uncertainty, a maximum value of 0.300 mg/m^3 is selected, three times the maximum selected for nominal conditions. A higher value is not selected because a tephra deposit of more than 1 cm (the maximum thickness for which analog data is available) would be an uncommon event south of Yucca Mountain in the area to be considered as the location of the receptor (CRWMS M&O 2000, Section 3.10.5.1) and because the influence of fluvial transport of ash on mass loading likely will be temporary and restricted to the vicinity of Fortymile Wash.

The distribution to be used in the biosphere model, which represents the increase in mass loading in the inactive outdoor environment the first year following a volcanic eruption at Yucca Mountain, is triangular with a mode of 0.060, minimum of 0.025, and maximum of 0.200 mg/m^3.

6.2.3 Active Indoor Environment

A review of applicable literature (See Section 4.1.1) was conducted to evaluate mass loading concentrations indoors following volcanic eruptions. Because few such measurements have been taken, an assumption (Section 5.2) was developed and is used with the results of the literature review to develop a distribution for the active indoor environment.

6.2.3.1 Literature Review

Buist et al. (1986a, Table 2) reported concentrations of TSP measured indoors in the weeks following the eruption of Mount St. Helens by the National Institute of Occupational Safety and Health. Average TSP concentrations were 0.09 mg/m^3 in homes (range = 0.03 to 0.20), 0.30 mg/m^3 in schools (range = 0.20 to 0.50), and 0.30 mg/m^3 in commercial establishments (range = 0.1 to 0.44). Buist et al. (1986a, p. 41) concluded that "Generally, there were very low levels of airborne respirable dust in homes and other buildings and, for the most part, it is likely that the general population received a very low exposure."

Searl et al. (2002) measured PM_4 and PM_{10} concentrations during 1996–2000 in areas where ash was being or had been deposited by the Soufriere Hills volcano. Personal exposure concentrations of PM_4 were 0.050 mg/m^3 for housekeepers (range = 0.012 to 0.105), 0.105 mg/m^3 for shopworkers (range = 0.083 to 0.126), 0.012 mg/m^3 for one housewife, and 0.039 mg/m^3 for one office worker (Searl et al. 2002, Table 8). To model population exposure, the authors estimated average personal exposure to PM_{10} during various activities and for four levels of ash concentrations (Searl et al. 2002, Table 11). The low ash and raised ash concentrations are the most analogous for this analysis because alert and very high concentrations occurred during less than five percent of days on the portions of the island where ash thickness was less than 5 cm (Searl et al. 2002, Table 6). The very high and alert concentrations appear to correspond to days when the Soufriere Hills volcano was erupting and the winds were blowing ash toward a community. Estimated concentrations of PM_{10} while active indoors were 0.05 to 0.15 mg/m^3 for low and raised ash concentrations, and 0.5 to 2.0 mg/m^3 for very high and alert concentrations. If the ratio of TSP to PM_{10} in this environment is approximately 2.5:1 (see Section 6.1.3), then corresponding TSP ratios for the low and raised ash conditions would be 0.125 and 0.375 mg/m^3.

6.2.3.2 Parameter Development

Because an insufficient number of measurements of mass loading in the active indoor environment following a volcanic eruption have been reported, an assumption was developed (Section 5.2) that predicts that changes in the active indoor environment will be proportional to changes predicted for the inactive outdoor environment. The distribution selected for the active indoor environment under nominal conditions is triangular with a mode of 0.100 mg/m^3 and a range of 0.060 to 0.175 mg/m^3. Based on measurements of TSP the year following the eruption of Mount St. Helens, and a review of literature from Mount St. Helens, Mt. Spurr, and Montserrat, it was predicted that outdoor mass loading would double the first year after an eruption at Yucca Mountain (Section 6.2.2). Thus, the predicted distribution of TSP in the first year following a volcanic eruption at Yucca Mountain is triangular with a mode of 0.200 mg/m^3 and a range of 0.120 to 0.350 mg/m^3.

For the inactive outdoor environment, the maximum value in the distribution was three times higher than that predicted for nominal conditions. The maximum for the active indoor environment was doubled for the following reasons. As explained in Section 5.2, the rate at which indoor concentrations are assumed to increase relative to outdoor concentrations is about twice that measured in most studies, and was selected to account for uncertainty in the relationship between indoor and outdoor concentrations during very dusty conditions. Increasing that ratio further is unreasonable because such an increase would be greater than any applicable measured value. Also, it is unlikely that people would allow their homes to be extremely dusty for a long period following an eruption. In contrast to outdoor dust concentrations, which cannot be controlled easily, indoor concentrations can be decreased easily by dusting, vacuuming, changing air filters, and keeping windows and doors shut.

Predicted and measured concentrations of TSP indoors during and immediately following the eruptions of Mount St. Helens and Soufriere Hills ranged from about 0.09 mg/m^3 to 0.375 mg/m^3, respectively. These values are similar to the minimum and maximum values of the predicted range for the indoor active environment, and this range and the assumption upon which it was based therefore appear to be reasonable.

The distribution to be used in the biosphere model, which represents the increase in mass loading in the active indoor environment the first year following a volcanic eruption at Yucca Mountain, is triangular with a mode of 0.100, minimum of 0.060, and maximum of 0.175 mg/m^3.

6.2.4 Asleep Indoor Environment

A review of applicable literature (See Section 4.1.1) was conducted to evaluate mass loading concentrations in the asleep indoor environment following volcanic eruptions. Because few such measurements have been taken, an assumption (Section 5.2) was developed and is used with the results of the literature review to develop a distribution for this environment.

6.2.4.1 Literature Review

Buist et al. (1983) measured personal TSP exposure concentrations of children ages 8 to 13 that were attending a summer camp in Oregon shortly after 1.2 cm of ash had fallen from the eruption of Mount St. Helens. Nighttime TSP concentrations were at or below the 0.01-mg/m^3 limit of detection of sampling equipment (Buist et al. 1983, p. 717).

Searl et al. (2002) measured PM_4 and PM_{10} concentrations during 1996–2000 in areas where ash was being or had been deposited by the Soufriere Hills volcano. To model population exposure, the authors estimated average personal exposure to PM_{10} during various activities and for four levels of ash concentrations (Searl et al. 2002, Table 11). The low ash and raised ash concentrations are the most analogous for this analysis, because alert and very high concentrations occurred during less than five percent of days on the portions of the island where ash thickness was less than 5 cm (Searl et al. 2002, Table 6). The very high and alert concentrations appear to correspond to days when the Soufriere Hills volcano was erupting and the winds were blowing ash toward a community. Estimated concentrations of PM_{10} while inactive were 0.03 to 0.1 mg/m^3 for low and raised ash conditions, and 0.3 to 1.0 mg/m^3 for very high and alert concentrations. If the ratio of TSP to PM_{10} in this environment was 1.6:1 (from

Thatcher and Layton 1995, Figure 3 [see Section 6.1.4]), then corresponding TSP ratios for the low and raised ash conditions would be about 0.048 and 0.160 mg/m^3.

6.2.4.2 Parameter Development

Because an insufficient number of measurements of mass loading in the active indoor environment following a volcanic eruption have been reported, an assumption was developed (Section 5.2) that predicts that changes in mass loading indoors following a volcanic eruption will be proportional to changes predicted for the inactive outdoor environment. The distribution selected for the asleep indoor environment under nominal conditions is triangular with a mode of 0.030 mg/m^3 and a range of 0.010 to 0.050 mg/m^3. Based on measurements of TSP the year following the eruption of Mount St. Helens, and a review of literature from Mount St. Helens, Mt. Spurr, and Montserrat, it was predicted that outdoor mass loading would double the first year after an eruption at Yucca Mountain (Section 6.2.2). Thus, the predicted distribution of TSP for the asleep indoor environment the first year following a volcanic eruption at Yucca Mountain is triangular with a mode of 0.060 mg/m^3 and a range of 0.020 to 0.100 mg/m^3.

For the inactive outdoor environment, the maximum value in the distribution was three times higher than that predicted for nominal conditions. The maximum for the asleep indoor environment was doubled for the following reasons. As explained in Section 5.2, the rate at which indoor concentrations increase relative to outdoor concentrations is about twice that measured in most studies, and was selected to account for uncertainty in the relationship between indoor and outdoor concentrations during very dusty conditions. Increasing that ratio further is unreasonable because such an increase would be greater than any applicable measured value. Also, it is unlikely that people would allow their homes to be three times as dusty for a long period following an eruption. In contrast to outdoor dust concentrations, which cannot be controlled easily, indoor concentrations can be decreased easily by dusting, vacuuming, changing air filters, and keeping windows and doors shut.

Predicted and measured concentrations of TSP indoors during and immediately following the eruptions of Mount St. Helens and Soufriere Hills ranged from less than 0.010 mg/m^3 to about 0.160 mg/m^3. The high value is the predicted value of Searl et al. (2002) for raised ash conditions while inactive, and is higher than the predicted maximum for the asleep indoor environment. The value from Searl et al. is based on sleeping and sedentary activities while awake, such as watching television (Searl et al. 2002, Table 10) and is 20 times higher than the maximum values measured by Buist et al. (1983). Because it includes concentrations while people are awake, it likely is an overestimate of concentrations while asleep. Thus, the predicted range for the asleep indoor environment, and the assumption upon which it was based, appear to be reasonable.

The distribution to be used in the biosphere model, which represents the increase in mass loading in the asleep indoor environment the first year following a volcanic eruption at Yucca Mountain, is triangular with a mode of 0.030, minimum of 0.010, and maximum of 0.060 mg/m^3,

6.2.5 Mass Loading —Crops

No measurements have been taken of mass loading near crops so it is assumed that the distribution of mass loading in fields where crops are growing is similar to or higher than that in the inactive outdoor environment, with a minimum value equal to the minimum value of the inactive outdoor environment, and a modal and maximum value twice that of the inactive outdoor environment. See Section 5.1 for justification of this assumption.

The distribution of mass loading in the inactive outdoor environment the first year following a volcanic eruption is predicted to have a mode of 0.120 mg/m^3, and a range of 0.050 to 0.300 mg/m^3. Based on the above assumption, the distribution of mass loading for crops is predicted to have a mode of 0.240 mg/m^3, and a range of 0.050 to 0.600 mg/m^3. As described in Section 6.2, this distribution is representative of the total concentration of resuspended particles following a volcanic eruption because mass loading for crops is not treated as a function of time in the biosphere model.

6.3 MASS LOADING TIME FUNCTION

The mass loading time function is used within the volcanic-eruption analysis of the TSPA model to calculate the change in dose through time resulting from a decrease in mass loading following a volcanic eruption, as shown in Equation 6.2-3.

Ash from a volcanic eruption initially would be more readily suspendable than the soil upon which it was deposited, and mass loading therefore would be higher than it was prior to the eruption (i.e., under nominal conditions defined in Section 6.1). Through time the tephra deposit would erode; become mixed into the soil; buried; removed from homes, yards, and other living areas; or otherwise become stabilized. That erosion, removal, and stabilization would result in a decrease in mass loading, with concentrations eventually returning to nominal conditions. Because of this change in mass loading through time, dose resulting from a volcanic eruption must be calculated in the TSPA model as a function of time.

If mass loading decreases exponentially through time, the mass loading time function in Equation 6.2-3 is expressed as:

$$S_{v,n} f(t) = S_{v,n} e^{-\lambda t} \qquad \text{Eq. 6.3-1}$$

where:

λ = Mass loading decrease constant (1/years).

t = Time (years); $t = 0$ is the first year after a volcanic eruption.

The other variables in this equation are defined for Equation 6.2-3.

An exponential decrease in mass loading following a volcanic eruption is selected for Equation 6.3-1 based on commonly used equations for predicting the change in concentrations of resuspended particles and radionuclides through time. Dahneke (1975, p. 194) developed a generalized exponential equation for particle resuspension of $N_t = N_0 e^{-\lambda t}$, where N_t =

concentration at time t, N_0 = initial concentration, λ = resuspension factor or decrease constant (i.e., an estimate of how quickly the decay occurs), and t = time. Anspaugh et al. (1975, p. 577-578) used a similar equation to predict resuspension of plutonium in desert soils on the Nevada Test Site. Similar exponential decay equations have been used to calculate resuspension in dose assessment models (Till and Meyer 1983, p. 5-32 through 5-33; IAEA, 1982, p. 20; 1992, Figure 1 on p. 13; Napier et al. 1988, p. 4.64).

Inverse or inverse power functions have also been used to predict concentrations of resuspended radionuclides (e.g., IAEA 1992, Figure 1 on p. 13; Garger et al., 1997, p. 1651). Garger et al. (1997, Figure 3 on p. 1654) evaluated how eight equations (six exponential, one inverse power, and one combination) predicted temporal changes in radionuclide concentrations following the accident at the Chernobyl nuclear power plant. Equations with an inverse power function generally predicated concentrations more accurately than the exponential equations in that mesic environment (Garger et al. 1997, p. 1655) because the exponential equations overestimated concentrations (i.e., did not calculate a rapid enough decay). However, an inverse decay function is less conservative than an exponential function (because it predicts a more rapid decrease in concentrations) and may not apply to arid regions such as the Nevada Test Site, where an exponential equation has proven to be effective (Anspaugh et al. 1975).

The mass loading decrease constant is the proportion of the mass loading concentration at the beginning of a year that is no longer readily available for resuspension at the end of that year. For example, a λ of 0.1 $year^{-1}$ indicates that about 90 percent ($e^{-0.1}$) of resuspendable ash present at the beginning of a year still is unstabilized and available for resuspension at the end of that year. Figure 6.3-1 is a plot of the decrease in mass loading per year for seven arbitrarily chosen values of λ.

The average annual concentration for a period of years *TI* ($S_{0,TI}$), and an initial concentration $S_{v,n}$ can be calculated using the following equation, which was developed by integrating Equation 6.3-1 between the times of zero and the time interval *TI* and dividing this by the time interval.

$$S_{\bar{x},TI} = \frac{\int dS_n}{\int dt} = \frac{S_{v,n}}{t} \times \frac{1}{\lambda} \times \left(1 - e^{-\lambda t}\right) \qquad \text{Eq. 6.3-2}$$

Concentrations of TSP measured before and after eruptions of Mount St. Helens were analyzed to predict the mass loading decrease constant for a volcanic eruption at Yucca Mountain. Literature from that and other volcanoes were reviewed to corroborate the rate at which mass loading returns to pre-eruptive conditions.

6.3.1 Data Analysis

Mount St. Helens TSP Data—TSP measurements for 1979−1982 from six sites in Washington that had about 0.5 to 10 mm of ash were plotted to evaluate the rate at which ash stabilized after the eruption of Mount St. Helens. The dataset (DTN MO0008SPATSP00.013) and methods used to select the six sites are described in Section 6.2.2.1.

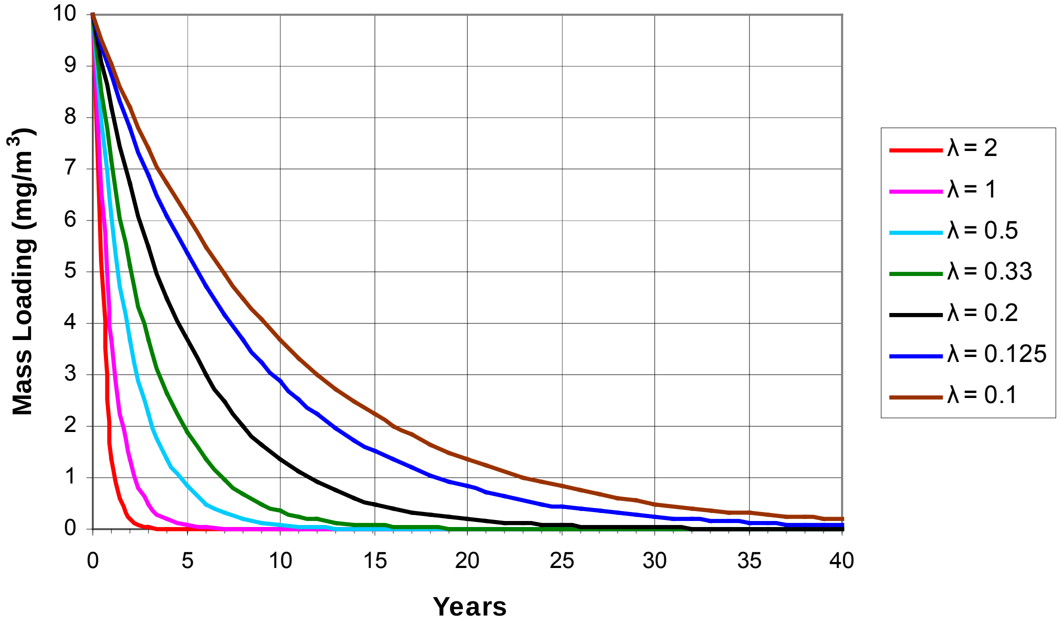


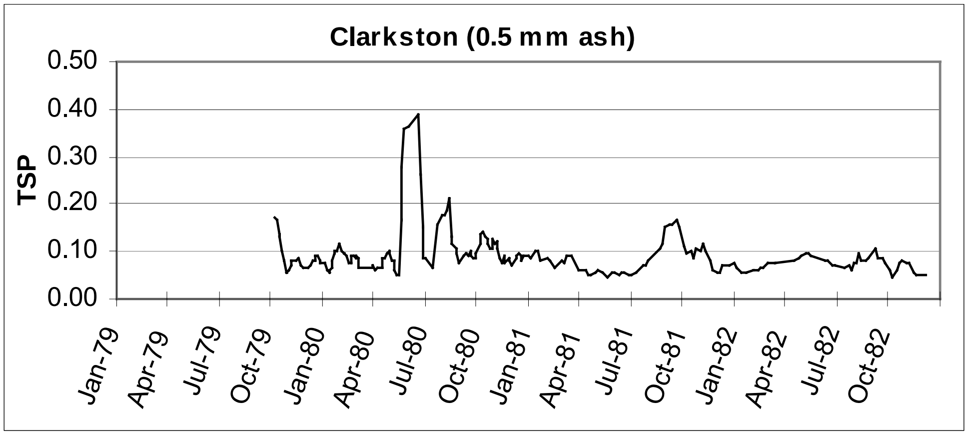
Figure 6.3-1. Examples of the rate of change of mass loading from a hypothetical initial concentration of 10 mg/m^3 for seven values of the mass loading decrease constant (λ)

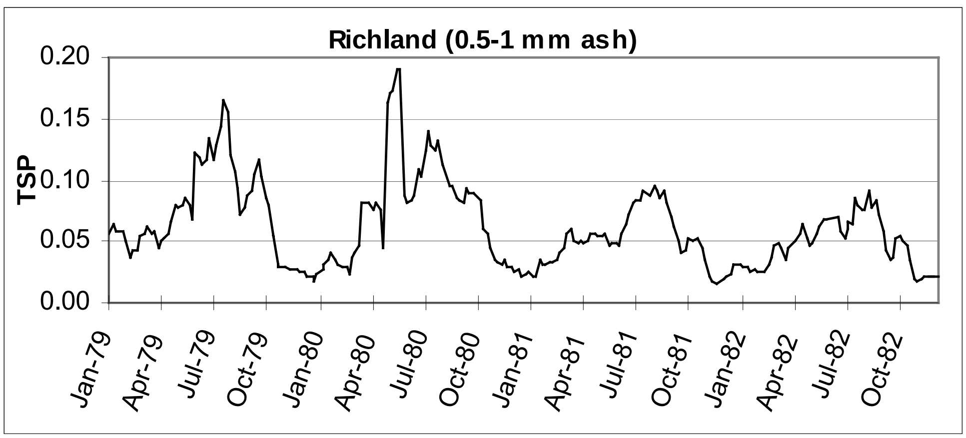
TSP concentrations at the sites are plotted in Figure 6.3-2. This figure displays five-measurement running averages, which were calculated to smooth changes over short periods. These averages were calculated as the average of the concentration for a date and the four previous measurements (Appendix C). Concentrations returned to pre-eruption levels at Clarkston, Richland, Longview, and Vancouver within about three months, and within about six to eight months at Spokane and Yakima. Average annual concentrations two years after the eruption were equal to pre-eruption concentrations at all sites (Table 6.2.2-1). The corresponding λ for this rate of decrease is at least 2.0 year^{-1}or greater (see Figure 6.3-1).

6.3.2 Literature Review

Buist et al. (1986b, p. 70) report changes in personal-exposure concentrations of respirable dust for loggers working in areas having substantial deposits of ash from Mount St. Helens. Dust concentrations for cutting crews were 0.900 mg/m^3 in June 1980 (one month or less after the major eruption of Mount St. Helens) and 0.270 mg/m^3 in September 1980. This is a 70% decrease in mass loading over four months (maximum of 122 days), or 0.57% per day (0.7/122 days x 100), which is approximately equal to a λ of 2.1 year^{-1} (0.57% per day x 365 days).

Buist et al. (1986a, p. 41) summarize results of monitoring of personal exposure to dust and ash for many other occupations and settings following the eruption of Mount St. Helens. Although they do not present data on how concentrations changed through time, they state that high occupational exposures were "largely restricted to the summer months" (i.e., 3–4 months following the eruption), and that "environmental exposures were also modest except in the path





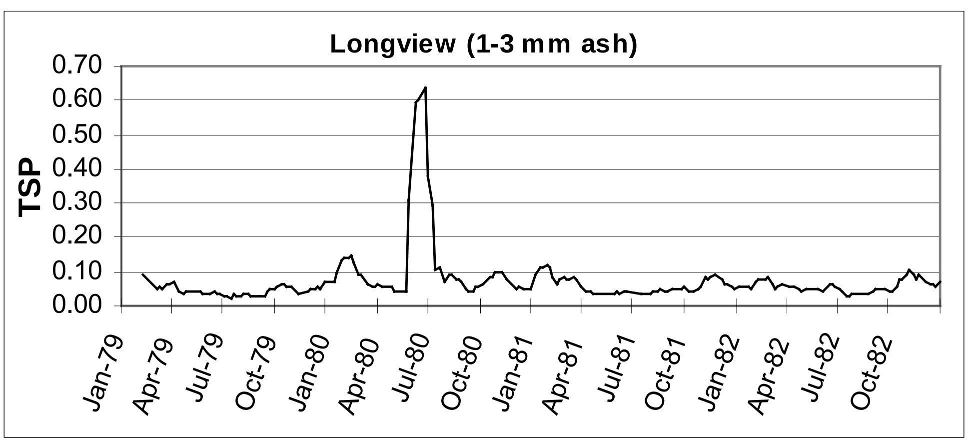
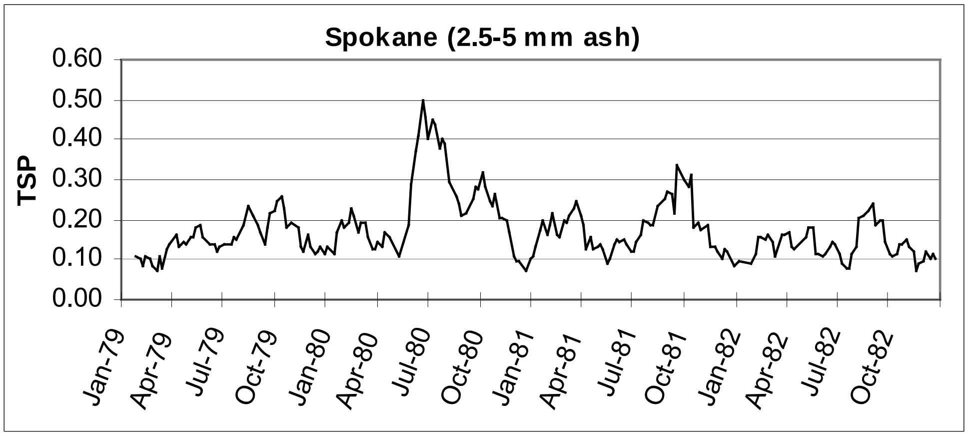
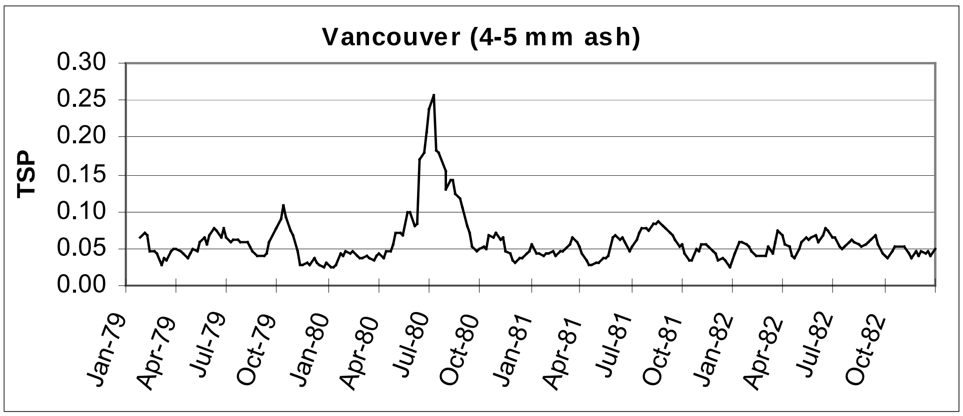


Figure 6.3-2. TSP concentrations (mg/m^3) at six sites in Washington before and after the eruption of Mount St. Helens in May-June 1980. TSP is presented as the running average of 5 consecutive measurements (Appendix D) (DTN: MO0008SPATSP00.013).





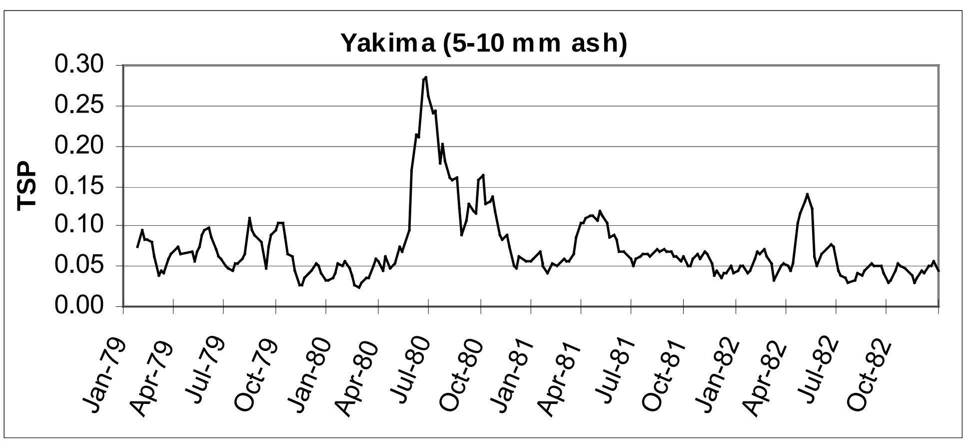


Figure 6.3-2. Continued.

of the plume for the few days immediately following the May 18, 1980 eruption." They also state that "In exposed areas, rain and weathering have tended to create a crust that has helped to reduce the aerosolization of the ash, and on farmed land, the ash has gradually become worked into the topsoil."

Gordian et al. (1996) presents a plot of PM_{10} concentrations in Anchorage, Alaska, before and after about 3 mm of ash were deposited from the August 1992 eruption of Mt. Spurr (McGimsey et al. 2001, p. 4). During the three months prior to the eruption, PM_{10} concentrations in Anchorage ranged from about 0.010 to 0.080 mg/m^3 (Gordian et al. 1996, Figure 1). The peak one-hour concentrations during the eruption was 3 mg/m^3 and the 24-hour average concentration the day after the eruption was 0.565 mg/m^3 (Gordian et al. 1996, p. 290). Concentrations returned to pre-eruption levels after about three months, although there were occasional peaks of 0.1–0.2 mg/m^3 for about nine months. By May 1993, PM_{10} concentrations had returned to pre-eruption levels. The corresponding λ for this rate of decrease is at least 2.0 year^{-1} (Figure 6.3-1).

Yano et al. (1990, p. 373) stated although concentrations as high as 2 mg/m^3 have been measured in high-exposure areas after the eruption of Mount Sakurijima (Japan), "these high levels of suspended particulate matter seldom last long, and they usually decrease rapidly to approximately 0.1 mg/m^3."

In summary, the mass loading decrease constant for six sites in Washington following the eruption of Mount St. Helens, and in Anchorage following the eruption of Mt. Spurr, was about 2.0 year^{-1} (see Figure 6.3-1). The average concentration for a decrease constant of 2 year^{-1}and a hypothetical S_v of 10 mg/m^3 is 0.5 mg/m^3 over 10 years and 0.25 mg/m^3 over 20 years (using Equation 6.3-2). This rapid decrease in mass loading following eruptions is corroborated by other reports of conditions following Mount St. Helens and from monitoring following the eruptions of Mt. Spurr and Mount Sakurijima.

6.3.3 Parameter Development

The data from Mount St. Helens is analogous to most climatic conditions and the thickness of the tephra deposit predicted for area south of Yucca Mountain. The climate at the four cities in eastern Washington examined (Clarkston [0 annual precipitation = 16.5 inches, 0 annual snowfall = 15.1 inches], Richland [0 precipitation = 7.0 inches, 0 snowfall = 10.2 inches], Spokane [0 precipitation = 16.2 inches, 0 snowfall = 42.1 inches] and Yakima [0 precipitation = 8.3 inches, 0 snowfall = 23.4 inches], NCDC 1998b) is predicted to be similar to that at Yucca Mountain for much of the next 10,000 years (USGS 2001, p. 67 and 74); therefore, the influence of precipitation and vegetation on consolidation and removal of ash at those sites following Mount St. Helens likely will be similar to that after an eruption at Yucca Mountain. A

There are, however, four differences between the conditions under which data from Mount St. Helens were measured and those expected at Yucca Mountain. These differences may be important sources of uncertainty in the use of information from Mount St. Helens and other volcanoes to develop a distribution of the mass load decay constant. First, the size and resuspendability of ash from non-basaltic volcanoes such as Mount St. Helens and other volcanoes may differ from that of the type of basaltic volcano predicted for Yucca Mountain. Second, climatic conditions at Mount St. Helens are wetter and cooler than current conditions at

Yucca Mountain. Third, no data are available on the rate of change in mass loading following an initial deposit of more than 1 cm. And fourth, all locations where changes in mass loading through time were measured after volcanic eruptions were outside of the volcanoes' watersheds; therefore, the only important source of ash was the initial, airborne deposit. Amargosa Valley is within the watershed of Yucca Mountain and ash initially deposited upstream of Amargosa Valley may be washed and blown into and through that valley.

If ash particles from non-basaltic volcanoes used as analogs in this analyses (Mount St. Helens, and to a lesser extent Soufriere Hills, Mt. Spurr, and Mount Sakurijima) are larger than those from a basaltic volcano of the type predicted at Yucca Mountain, then predicted concentrations of resuspended ash developed from those analogs may underestimate mass loading following an eruption at Yucca Mountain and overestimate the rate at which concentrations decrease through time. All of the following measurements of particle size distributions are presented as percent mass. Hill and Connor (2000, p. 71) report that ash 21 km from the vent of the basaltic Cerro Negro volcano had about two percent of particles by weight <10 μm, 10 percent <60 μm, and 50 percent <200 μm. They report that other fall deposits from larger basaltic cinder cone eruptions (Paricutin, Tolbachik, Sunset Crater) may contain two to five percent weight of particles <10 μm at 20 km. Hill and Connor (2000, p. 71) also state that basaltic volcanoes may produce unusually fine-grained deposits (>40 percent of particle weight <60 μm) late in an eruption during subsurface brecciation events. About 10 percent or less of the ash from Mount St. Helens was <10 μm (Craighead et al. 1983. p. 6; Buist et al. 1986a, p. 40). Ash at two sites 30 to 35 km east of Anchorage from the August 1992 eruption of Mt. Spurr had about 30 to 35% of particles ≤63 μm, 8 to 15% <15 μm, and 5 to 10% ≤7.5 μm (McGimsey et al. 2001, Figure 12 [particle sizes are midpoints of values from bar charts]). However, ash collected at a site about 25 km west of Anchorage (closer to Mt. Spurr) had few or no particles ≤63 μm. Ash from Soufriere Hills had 13 to 20 percent weight of particles ≤10 μm and 60 to 70 percent weight of particles 10 to 125 μm (Baxter et al. 1999, p. 1142). Thus, ash from the volcanoes used as analogs in this analysis appear to have had higher concentrations of fine particles than that from basaltic volcanoes. In addition, Baxter (in McKague 1998, Enclosure 3 – Item 17) stated that "For exposure estimates, the [PM_{10}] results obtained from Mount St. Helens and Monsterrat will almost certainly need to be reduced by a factor to allow for the coarser material emitted at Cerro Negro." Thus, ash particles from the analog volcanoes used in this analysis generally were similar in size or smaller than those from basaltic volcanoes. However, the amount of fine ash deposited at a site can be quite variable, depending on wind direction and speed, distance from the volcano, and possibly other factors (Sarna-Wojcicki et al. 1982, pp. 585-588, McGimsey et al. 2001, Figure 12). To account for this variability, the lower bound of the distribution of the decay constant described below is smaller (i.e., has a slower decay rate) than the value of about 2 measured after eruptions of Mount St. Helens and Mt. Spurr.

The current, arid climate at Yucca Mountain is predicted to continue for less than 1,000 years (USGS 2001, Table 2). The rate of change in mass loading measured in eastern Washington under wetter and cooler conditions may not apply to current conditions. However, concentrations of airborne particulates currently do not differ much among arid, rural sites with less than 20 inches of precipitation and less than about 45 inches of snowfall (Appendix C); therefore, changes in mass loading through time likely would not differ greatly between current and future climates predicted for Yucca Mountain. To ensure that uncertainty in the effects of current, arid conditions are not underestimated, the lower bound of the distribution of the decay constant below is smaller than the value measured at analog sites.

The analog data from Mount St. Helens used in this analysis is from ash deposits of 10 mm or less. Although an ash deposit greater than 10 mm is unlikely in the area south of Yucca Mountain at the receptor location (CRWMS M&O 2000, Section 3.10.5.1), the influence of such a deposit on the mass loading time function must be included. Because there is much more uncertainty in the decay constant for ash deposits ≥10 mm, separate distributions of this parameter are developed below for deposits <10 and ≥10 mm deep.

There is also uncertainty associated with the effects of aeolian and fluvial redistribution of ash into northern Amargosa Valley. Large quantities of ash from an eruption at Yucca Mountain may be deposited in the Fortymile Wash watershed. During and after very heavy precipitation events, some of the ash in that watershed would be washed downstream and deposited in Amargosa Valley. If the quantity of resuspendable ash at or near the location of the receptor is greater than the quantity of resuspendable soil now washed through that area, dust concentrations would increase temporarily after deposition.

The Fortymile Wash watershed starts approximately 25 miles north of Yucca Mountain, and continues southward along the eastern edge of Yucca Mountain before entering Amargosa Valley. The wash terminates at the Amargosa River in western Amargosa Valley. It drains the southern part of Pahute Mesa, western Jackass Flats, and the eastern slopes of Fortymile Wash. Just south of the southern boundary of the Nevada Test Site (i.e., about 20 km south of Yucca Mountain), the Fortymile Wash channel changes from a moderately confined channel to several distributary channels that are poorly defined (Tanko and Glancy 2001, Figure 1). Fortymile Wash flows into Amargosa Valley infrequently and flows into the Amargosa River have been documented only three times since 1969. During the two floods that have been well studied (1995 and 1998), unusually severe or long lasting rains combined with melting of the snowpack in the northern part of the watershed resulted in flows throughout all or most of the major tributaries of Fortymile Wash and the Amargosa River (Beck and Glancy 1995; Tanko and Glancy 2001). Thus, any sediment from one portion of the watershed was mixed with and buried within sediment from throughout the watershed.

Any materials that wash into Amargosa Valley would be restricted primarily to the bottoms and sides of the channels of Fortymile Wash. Although Fortymile Wash consists of a series of diffuse channels in Amargosa Valley, the surface area of the channels is small relative to the entire valley. Tephra blankets deposited throughout entire regions following other volcanic eruptions resulted in increases in resuspended particles for only months (e.g., Figure 6.3-1); therefore, it is reasonable to expect that ash redistributed during flooding that is restricted to the channels of Fortymile Wash and well mixed with other sediment would affect mass loading for a much shorter period of time, likely days to at most weeks. In addition, any increase in mass loading likely would be small relative to the change predicted for the first year following an eruption, which were caused by widespread, undiluted tephra deposits. To account for uncertainty in how long mass loading would remain high after such flooding, how much higher than background levels it would be, and how frequently Fortymile Wash would flood in the future, the selected modal and minimum values of the mass loading decrease constant are much lower than those measured following other volcanic eruptions.

For an initial ash thickness of less than 10 mm, a triangular distribution of the mass load decrease constant with a mode of 0.33 $year^{-1}$, maximum of 2.0 $year^{-1}$, and minimum of 0.2 $year^{-1}$ is selected. The modal rate decreases about 96 percent over 10 years (Figure 6.3-1) and has an average annual concentration over 10 years of 2.9 mg/m^3 for a hypothetical S_v of 10 mg/m^3 (from Equation 6.3-2). This corresponds to a rate that takes at least 10 times longer to approach pre-eruption levels, and an average annual concentration over 10 years about 6 times greater than for a λ of 2 $year^{-1}$ (0.5 mg/m^3), the approximate decrease constant following the eruptions at Mount St. Helens and other volcanoes for which data is available. The maximum value selected for this distribution is approximately equal to the rate measured following Mount St. Helens. The minimum decreases about 86 percent in 10 years and has an average annual concentration over 10 years of 4.3 mg/m^3 for a hypothetical S_v of 10 mg/m^3, more than eight times greater than that for a λ of 2 $year^{-1}$. If the TSPA analysis uses a 10-year time step, the increase in mass loading at 10 years (the second time step after the eruption) for an initial tephra deposit <10 mm will range from about zero to 14 percent of S_v (calculated as $S_v e^{-\lambda 10}$, from equation 6.3-1), with a mode of about four percent.

For an initial ash thickness of 10 mm or greater, a triangular distribution of the mass load decrease constant with a mode of 0.2 $year^{-1}$, maximum of 1.0 $year^{-1}$, and minimum of 0.125 $year^{-1}$ is selected. The modal rate decreases about 86 percent in 10 years and 98 percent in 20 years (Figure 6.3-1). The average annual concentration over 10 years for a λ of 0.2 $year^{-1}$ and a hypothetical S_v of 10 mg/m^3 is 4.3 mg/m^3 (from Equation 6.3-2), more than eight times greater than for a λ of 2.0 $year^{-1}$. The maximum value of this distribution is slightly larger than the decay constant of about 2.0 $year^{-1}$ measured after other eruptions, and was selected because some predicted ash depths covered by this distribution are only slightly greater than the 10-mm maximum ash thickness for analog data from Mount St. Helens. The minimum decay constant of 0.125 $year^{-1}$ results in a decrease of 71% over 10 years, 92% decrease over 20 years, and 98% decrease over 30 years. The average annual concentrations for a λ of 0.125 $year^{-1}$ and a hypothetical S_v of 10 mg/m^3 are 5.7 and 3.7 mg/m^3 over 10 and 20 years, respectively, more than an order of magnitude higher than for a λ of 2.0 $year^{-1}$. If the TSPA analysis uses a 10-year time step, the increase in mass loading at 10 years for an initial tephra deposit of ≥10 mm will range from about zero to 29 percent of S_v (calculated as $S_v e^{-\lambda 10}$, from equation 6.3-1), with a mode of about 14 percent.

7. CONCLUSIONS

This analysis report documents the selection of distributions for mass loading and the mass loading decrease function for use in the biosphere model. This information is summarized in Table 7-1 and contained in DTN MO0305SPAINEXI.001. The only limitation on the use of these distributions and the function is that they are intended for the current and glacial transition (equals intermediate glacial) climatic conditions in the Yucca Mountain reference biosphere. They must be used with caution for other, more mesic and colder conditions. Uncertainties in the inputs and assumption related to use of analog data, climate change, thickness of the initial tephra deposit, and redistribution of tephra by aeolian and fluvial transport are described in Section 6.

Table 7-1. Inhalation Exposure Input Parameters for the Biosphere Model

Parameter Environment or Condition	Type of Distribution	Mode	Minimum	Maximum
Mass Loading – Nominal Conditions				
Active Outdoors (mg/m^3)	Triangular	5.000	1.000	10.000
Inactive Outdoors (mg/m^3)	Triangular	0.060	0.025	0.100
Active Indoors (mg/m^3)	Triangular	0.100	0.060	0.175
Asleep Indoors (mg/m^3)	Triangular	0.030	0.010	0.050
Crops (mg/m^3)	Triangular	0.120	0.025	0.200
Mass Loading – Post-Volcanic Conditions[a]				
Active Outdoors (mg/m^3)	Triangular	2.500	0.000	5.000
Inactive Outdoors (mg/m^3)	Triangular	0.060	0.025	0.200
Active Indoors (mg/m^3)	Triangular	0.100	0.060	0.175
Asleep Indoors (mg/m^3)	Triangular	0.030	0.010	0.060
Crops (mg/m^3)	Triangular	0.240	0.050	0.600
Mass Loading Decrease Constant = $S_0 e^{-\lambda t}$, with λ =				
For initial ash depth <10 mm (1/year)	Triangular	0.33	0.2	2.0
For initial ash depths ≥10 mm (1/year)	Triangular	0.20	0.125	1.0

Notes: DTN: MO0305SPAINEXI.001.

[a] Distributions for post-volcanic conditions for human environments represent the predicted change in mass loading the first year following a volcanic eruption. These values must be added to predicted values for nominal conditions to determine the total predicted mass load for post-volcanic conditions. The distribution for crops represents the total mass loading the first year following an eruption and should not be added to predicted values for nominal conditions.

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8.2 CODES, STANDARDS, AND REGULATIONS

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8.3 DATA TRACKING NUMBERS CITED

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TM000000000001.105. Particulate Sampler Data Records and Filter Weight Logs, April - June 1997. Submittal date: 07/21/1997.

TM000000000001.108. Particulate Sampler Data Records and Filter Weight Logs, July - September 1997. Submittal date: 10/22/1997.

8.4 DEVELOPED DATA

MO0305SPAINEXI.001. Inhalation Exposure Input Parameters for the Biosphere Model. Submittal date: 5/27/03.

APPENDIX A. MASS LOAD SENSITIVITY ANALYSIS

The analysis described in this appendix was conducted to evaluate the sensitivity of calculations of mass of resuspended particles that are inhaled to changes in the input parameter values.

The mass of inhaled particles was calculated in this analysis using the following equation.

$$Inhalation = \sum_{n} t_n BR_n S_n$$

where:

> *Inhalation* = total mass of inhaled particles (mg).
>
> n = environment.
>
> t_n = time spend in environment $_n$ (hours).
>
> BR_n = breathing rate in environment n (m^3/hour).
>
> S_n = Mass loading concentration in environment n (mg/m^3).

This analysis was conducted by holding all parameters at an expected value except one parameter being examined (Table A-1). The ranges of parameter values used in this analysis were selected only to evaluate sensitivity and are intended to be reasonable estimates of the range of average annual values for the Amargosa Valley population and of average annual conditions in Amargosa Valley. They are not intended to represent the recommended values for calculating BDCFs. Nor is it necessary that the values used in this analysis match those used to calculate BDCFs, because the goal here is only to understand the relative importance of each parameter to the calculation of mass of inhaled particles.

Results—The mass of inhaled particles is most sensitive to changes in mass load in the active outdoor environment, primarily because mass loading concentrations are one to two orders of magnitude higher during dust-generating activities outdoors than in other environments (Table A-1). Changes in mass loading in the active indoor environment is the third-most-important parameter, primarily because the large amount of time spent in that environment. Changes in mass loading in the inactive outdoor and asleep indoor environments have little effect on inhalation of particulates.

Changes in time spent in the outdoor active environment have the second largest effect on the mass of particulates inhaled. This is due primarily to the large concentrations of particulates in that environment, but also to uncertainty in estimates of time spent outdoors. Changes in time spent in other environments have little influence on inhalation, in part because of the narrow range of values. Ranges of time spent in each environment are narrow because they represent variation and uncertainty around the mean of the Amargosa Valley population, as required by 10 CFR 63.312(b).

Breathing rates have little influence on the rate of inhalation of particulates, primarily because variation in those rates is low.

Table A-1. Mass Loading Sensitivity Analysis

Environment Parameter	Expected Value	Minimum Values Min	Inhalation (mg)[b]	% Change[c]	Maximum Values Max	Inhalation (mg)[b]	% Change[c]
Active Outdoors							
Time (hours)	0.5	0.2	3.874	-39.7%	1	10.674	66.2%
Breathing Rate (m^3/hr)	1.7	1.5	5.924	-7.8%	1.9	6.924	7.8%
Mass Load (mg/m^3)	5.0	1.0	3.024	-52.9%	10.0	10.674	66.2%
Inactive Outdoors							
Time	1.0	0.8	6.402	-0.3%	2.0	6.534	1.7%
Breathing Rate (m^3/hr)	1.1	0.95	6.409	-0.2%	1.25	6.439	0.2%
Mass Load (mg/m^3)	0.1	0.05	6.369	-0.9%	0.3	6.644	3.4%
Active Indoors							
Time	11.5	10	6.176	-3.9%	12.5	6.589	2.6%
Breathing Rate (m^3/hr)	1.1	0.95	6.165	-4.0%	1.25	6.682	4.0%
Mass Load (mg/m^3)	0.15	0.05	5.159	-19.7%	0.3	8.321	29.5%
Asleep Indoors							
Time	8.3	8.1	6.420	-0.1%	8.5	6.428	0.1%
Breathing Rate (m^3/hr)	0.4	0.35	6.403	-0.3%	0.45	6.444	0.3%
Mass Load (mg/m^3)	0.05	0.01	6.291	-2.1%	0.1	6.590	2.6%
Total Dust Inhaled (mg)	6.424[a]						

Notes: [a] Calculated as the sum over four environments of the expected values of (time x breathing rate x mass load).
[b] Total dust inhaled with all values held at the expected value except one, calculated using the equation in footnote a.
[c] Percent change in total dust inhaled from the expected value (6.424mg).

APPENDIX B. TSP CONCENTRATION—ACTIVE OUTDOOR ENVIRONMENT

This appendix summarizes information on TSP concentrations from rural, agricultural sites obtained from the EPA (DTN MO0210SPATSP01.023) and used in this analysis. Table B-1 is a list of average annual TSP concentrations for all rural agricultural sites in Arizona, California, Idaho, Nevada, New Mexico, Oregon (excluding those sites west of the Cascade Mountains), Utah, and Washington. Note that TSP concentrations are in units of $\mu g/m^3$, the unit of measure reported by the EPA. Particulate concentrations in the remainder of this analysis are in units of mg/m^3.

Table B-2 lists descriptive information about each rural, agricultural TSP monitoring site, including average annual precipitation and snowfall from the U.S. National Climatic Data Center (NCDC 1998a,b).

Table B-1. Average Annual Concentrations of TSP ($\mu g/m^3$) from Rural, Agricultural Monitoring Sites in the Western United States.

					$\mu g/m^3$	
Site ID	**State**	**City**	**County**	**Year**	**Annual Average**	**Overall Average**
04-007-0003	Arizona	Miami	Gila	1974	62.3	49.8
				1975	37.2	
04-007-1902	Arizona	Miami	Gila	1975	24.5	29.6
				1976	36.6	
				1977	45.8	
				1978	20	
				1979	29.5	
				1980	16.5	
				1981	49.2	
				1982	15	
04-013-0008	Arizona	Guadalupe	Maricopa	1973	25.9	130.9
				1974	153.1	
				1975	172.7	
				1976	172	
04-019-0006	Arizona	Tuscon	Pima	1971	132.5	132.5
04-019-0009	Arizona	Tuscon	Pima	1973	118	81.3
				1974	74.7	
				1975	63.8	
				1976	68.5	
04-019-0010	Arizona	Tuscon	Pima	1974	92.4	88.7
				1975	84.9	
06-013-1002	California	Bethel Island	Contra Costa	1986	40.8	41.1
				1988	48.4	
				1989	41.5	
				1990	39.7	
				1991	42.5	
				1994	33.8	
06-019-1002	California	Five Points	Fresno	1972	62.9	77.7
				1973	67.9	

					μg/m³	
Site ID	**State**	**City**	**County**	**Year**	**Annual Average**	**Overall Average**
				1974	88.4	
				1975	75.7	
				1976	90.1	
				1977	93.1	
				1978	87.8	
				1979	89.5	
				1980	83.8	
				1981	80	
				1982	62.6	
				1983	59.9	
				1984	68.4	
06-019-3001	California	Parlier	Fresno	1972	82.7	94.3
				1973	66	
				1974	104.8	
				1975	94.2	
				1976	132.6	
				1977	121.7	
				1978	57.8	
06-027-0002	California	Bishop	Inyo	1980	32.3	25.4
				1981	29.9	
				1982	17.4	
				1983	16	
				1984	31.8	
				1985	26.1	
				1986	24.9	
				1987	24.5	
06-027-0011	California	Olancha	Inyo	1986	15.8	22.6
				1987	25.8	
				1988	26.3	
06-031-0002	California	Corcoran	Kings	1980	131.2	120.2
				1981	153.9	
				1982	101.2	
				1983	94.6	
06-031-1002	California	Kettleman City	Kings	1980	107.3	86.4
				1981	99.7	
				1982	65	
				1983	68.6	
				1984	90.6	
				1985	91.4	
				1986	95.4	
				1987	84.1	
				1988	75.2	
06-033-0002	California	Kelseyville	Lake	1980	39.3	33.8
				1981	36	
				1982	45	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
				1983	28.7	
				1984	28.6	
				1985	32.1	
				1986	27.2	
				1987	33.3	
06-033-0003	California	Upper Lake	Lake	1980	18	19.0
				1981	20.4	
				1982	18	
				1983	19.6	
06-049-1001	California	Cedarville	Modoc	1980	22.1	16.9
				1981	24.6	
				1982	15.1	
				1983	15.3	
				1984	11.8	
				1985	12.3	
06-061-0001	California	Auburn	Placer	1980	41.5	39.8
				1981	46.6	
				1982	33.6	
				1983	34.3	
				1984	43.1	
06-071-1101	California	Twentynine Palms	San Bernardino	1979	51.1	48.7
				1980	50.1	
				1981	53	
				1982	40.7	
				1983	45.1	
				1984	56.4	
				1985	49.9	
				1986	49.2	
				1987	47.7	
				1988	55.1	
				1989	37	
06-083-1011	California	Jalama	Santa Barbara	1987	44.4	45.2
				1988	47.1	
				1989	41.1	
				1990	46	
				1991	46	
				1992	44.9	
				1993	46.9	
06-083-1012	California	Concepcion	Santa Barbara	1987	42.5	43.1
				1988	43	
				1989	47.6	
				1990	38	
				1991	59.5	
				1992	36.7	
				1993	34.1	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
06-083-1015	California	Gaviota	Santa Barbara	1988	28.5	24.1
				1989	24.3	
				1990	23.6	
				1991	25.1	
				1992	25.9	
				1993	17.4	
06-083-1016	California	Gaviota	Santa Barbara	1988	28	25.3
				1989	26.2	
				1990	24.7	
				1991	28.2	
				1992	27.9	
				1993	16.7	
06-083-1017	California	Gaviota	Santa Barbara	1987	36.2	38.5
				1988	35.7	
				1989	39.6	
				1990	38.6	
				1991	38	
				1992	39.6	
				1993	42	
06-083-1019	California	Gaviota	Santa Barbara	1987	23.5	29.9
				1988	27.1	
				1989	33.7	
				1990	32.1	
				1991	29.2	
				1992	34.6	
				1993	29.1	
06-083-1020	California	Isla Vista	Santa Barbara	1988	43.9	42.7
				1989	46.3	
				1990	47.1	
				1991	40.8	
				1992	42.2	
				1993	36	
06-083-1030	California	Concepcion	Santa Barbara	1987	42.7	38.0
				1988	38.5	
				1989	36.3	
				1990	37.3	
				1991	37.5	
				1992	35.9	
06-083-4003	California	Vandenburg AFB	Santa Barbara	1987	34	31.2
				1988	35.1	
				1989	33	
				1990	31.3	
				1991	27.5	
				1992	25.7	
				1993	31.5	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
06-083-5001	California	Vandenburg AFB	Santa Barbara	1986	29.9	36.9
				1987	36.5	
				1988	44.2	
06-089-1002	California	Burney	Shasta	1985	40.7	33.5
				1986	26.3	
06-103-1001	California	Los Molinos	Tehama	1980	57.9	46.8
				1981	48.2	
				1982	44.6	
				1983	42.8	
				1984	45.9	
				1985	49.3	
				1986	43.3	
				1987	42.7	
06-111-0004	California	Piru	Ventura	1982	50.4	46.8
				1983	43.9	
				1984	53.6	
				1985	51	
				1986	45.3	
				1987	45.1	
				1988	38.5	
06-111-0005	California	Oak View	Ventura	1983	33.1	37.6
				1984	45.1	
				1985	41.8	
				1986	32.5	
				1987	35.6	
06-111-1101	California	Piru	Ventura	1979	65.3	64.3
				1980	63.3	
06-111-3001	California	El Rio	Ventura	1979	79.3	63.5
				1980	63	
				1981	70.2	
				1982	47.2	
				1983	45.7	
				1984	65.6	
				1985	68.8	
				1986	64	
				1987	60	
				1988	61.5	
				1989	67.5	
				1990	68.6	
				1991	64.4	
06-113-4001	California	Dunnigan	Yolo	1979	48.2	44.2
				1980	55.9	
				1981	48.8	
				1982	44.5	
				1983	33.2	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
				1984	43	
				1985	42.8	
				1986	39	
				1987	43.7	
				1988	49.8	
				1989	46.1	
				1990	44.9	
				1991	35.2	
06-115-0002	California	Smartsville	Yuba	1980	38.3	26.6
				1983	14.8	
16-001-0001	Idaho	Boise	Ada	1972	39.3	44.0
				1973	52.3	
				1974	61.3	
				1975	41.2	
				1976	45.3	
				1977	58.9	
				1978	50.4	
				1979	49.4	
				1980	38.3	
				1981	42.4	
				1982	37.2	
				1983	32.4	
				1984	38.7	
				1985	49.4	
				1986	45.2	
				1987	46.2	
				1988	39.2	
				1989	44.4	
				1990	38.1	
				1991	29.9	
16-005-1003	Idaho	Pocatello	Bannock	1970	87.8	67.5
				1971	55.9	
				1972	58.9	
16-011-0001	Idaho	Grandview	Bingham	1971	49.3	49.3
16-029-0001	Idaho	Soda Springs	Caribou	1971	69.5	69.5
16-029-0002	Idaho	Conda	Caribou	1971	33.6	38.1
				1972	36.3	
				1973	43.1	
				1976	61.7	
				1977	57.7	
				1978	38.1	
				1979	26.7	
				1980	37.6	
				1981	45.8	
				1982	34.8	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
				1983	27.9	
				1984	29	
				1985	36.3	
				1986	25.3	
				1987	30	
				1988	45.3	
16-053-0001	Idaho	Jerome	Jerome	1975	57.9	47.0
				1976	41.9	
				1977	65.8	
				1978	29.6	
				1979	35.3	
				1980	48.9	
				1981	49.4	
16-055-1002	Idaho	Coeur D'Alene	Kootenai	1970	49.1	51.5
				1971	43.3	
				1972	45.9	
				1973	69	
				1977	51.8	
				1978	44.3	
				1979	45.2	
				1980	63.6	
16-077-0005	Idaho	Pocotello	Power	1970	164.9	118.0
				1971	71.1	
16-083-0003	Idaho	Twin Falls	Twin Falls	1986	49.7	47.3
				1987	48.3	
				1988	44	
16-083-0004	Idaho	Hansen	Twin Falls	1989	32	38.2
				1990	39.2	
				1991	41.2	
				1992	40.2	
16-083-1001	Idaho	Twin Falls	Twin Falls	1971	49.5	44.7
				1972	45.6	
				1973	38.9	
32-003-1003	Nevada	Moapa	Clark	1972	61.2	61.2
32-031-1004	Nevada	Sparks	Washoe	1974	65.8	54.2
				1975	48.1	
				1976	43.1	
				1977	45	
				1978	46.3	
				1979	82.9	
				1980	70.7	
				1981	53.7	
				1982	43.1	
				1983	41.9	
				1984	53.3	

Site ID	State	City	County	Year	μg/m³ Annual Average	Overall Average
				1985	56.5	
32-031-2003	Nevada	Wadsworth	Washoe	1973	39	41.4
				1974	39.2	
				1975	45.9	
35-006-0007	New Mexico	Bluewater	Cibola	1981	91.3	75.2
				1982	59	
35-013-0004	New Mexico	Sunland Park	Dona Ana	1973	57.4	80.4
				1974	65.5	
				1975	63.1	
				1976	80.7	
				1977	76.3	
				1978	91.1	
				1979	81.5	
				1980	82.7	
				1981	97.5	
				1982	84.1	
				1983	77.6	
				1984	77.9	
				1985	71.5	
				1986	74.5	
				1987	92.9	
				1988	103.3	
				1989	90	
35-013-0006	New Mexico	Afton	Dona Ana	1973	75.1	44.9
				1974	28.6	
				1975	30.9	
35-013-0016	New Mexico	Anthony	Dona Ana	1988	132.3	137.5
				1989	142.6	
35-017-0002	New Mexico	Hurley	Grant	1973	115.9	84.8
				1974	49.8	
				1975	88.7	
35-045-0013	New Mexico	La Plata	San Juan	1973	33.9	33.5
				1974	34.2	
				1975	32.4	
35-045-0014	New Mexico	Kirtland	San Juan	1974	39	43.9
				1975	26.3	
				1976	72	
				1977	47.2	
				1978	47.1	
				1979	60.8	
				1980	57.8	
				1981	46.1	
				1982	40.1	
				1983	29.9	
				1984	40.9	

Site ID	State	City	County	Year	µg/m^3 Annual Average	Overall Average
				1985	39	
				1987	31.6	
				1988	36.1	
35-045-0015	New Mexico		San Juan	1974	35.6	28.9
				1975	22.1	
35-045-0021	New Mexico	None	San Juan	1977	36.3	36.3
35-061-0007	New Mexico	Bluewater	Valencia	1977	64.5	70.9
				1978	64.5	
				1979	73.4	
				1980	72.5	
				1981	79.5	
41-059-1001	Oregon	Pendelton	Umatilla	1972	35.5	40.4
				1973	39.4	
				1974	65.6	
				1975	30.3	
				1976	31.4	
49-015-0002	Utah	Hunington	Emery	1975	23.6	29.6
				1976	27.8	
				1977	34.3	
				1978	32.8	
49-015-0003	Utah		Emery	1974	12.6	16.9
				1977	23.8	
				1978	19.5	
				1979	11.8	
49-027-0002	Utah	Delta	Millard	1979	41	41.0
53-039-0002	Washington	Bingen	Klickitat	1975	50.3	56.2
				1976	59.8	
				1977	58	
				1978	56.8	
53-071-1001	Washington	Wallula Junction	Walla Walla	1983	48.7	65.6
				1984	59.7	
				1985	56.1	
				1986	51.2	
				1987	71	
				1988	84.8	
				1989	70.7	
				1990	80.5	
				1991	67.8	
53-075-0002	Washington	Pullman	Whitman	1975	22.6	37.6
				1976	41.8	
				1977	48.3	
53-077-0003	Washington	Sunnyside	Yakima	1982	61.9	61.7
				1983	56.5	
				1984	53.3	
				1985	56.2	

Site ID	State	City	County	Year	µg/m^3 Annual Average	Overall Average
				1986	54.2	
				1987	69.5	
				1988	60.2	
				1989	61.1	
				1990	70.6	
				1991	73.6	

Notes: DTN: MO0210SPATSP01.023

Table B-2. Average concentration of TSP (mg/m^3) at Rural, Agricultural Monitoring Sites in the Western United States.

				Inches					
EPA Site ID	State	City	County	0 Snow-fall	0 Precip-itation	Weather station	0 TSP (mg/m^3)	N Years	Comments
04-007-0003	Arizona	Miami	Gila	2.9	19.3	25512	0.050	2	Duplicate with 04-007-1902
04-007-1902	Arizona	Miami	Gila	2.9	19.3	25512	0.030	8	Selected
04-013-0008	Arizona	Guadalupe	Maricopa	0.0	8.9	28499	0.131	4	Has atypical values due to updraft
04-019-0006	Arizona	Tuscon	Pima	0.0	13.9	28795	0.133	1	Duplicate with 04-019-0010
04-019-0009	Arizona	Tuscon	Pima	0.0	13.9	28795	0.081	4	Near power plant substation
04-019-0010	Arizona	Tuscon	Pima	0.0	13.9	28795	0.089	2	Selected
06-013-1002	California	Bethel Island	Contra Costa	0.0	12.7	45232	0.041	6	Selected
06-019-1002	California	Five Points	Fresno	0.2	6.6	43083	0.078	13	Selected
06-019-3001	California	Parlier	Fresno	0.1	10.9	43257	0.094	7	Duplicate with 06-031-1002
06-027-0002	California	Bishop	Inyo	8.0	5.3	40822	0.025	8	Selected
06-027-0011	California	Olancha	Inyo	4.2	6.7	43710	0.023	3	Duplicate with 06-027-0002
06-031-0002	California	Corcoran	Kings	0.1	7.2	42012	0.120	4	Duplicate with 06-031-1002
06-031-1002	California	Kettleman City	Kings	0.1	7.2	42012	0.086	9	Selected
06-033-0002	California	Kelseyville	Lake	0.5	29.1	44701	0.034	8	Precipitation >20 inches
06-033-0003	California	Upper Lake	Lake	0.5	29.1	44701	0.019	4	Precipitation >20 inches
06-049-1001	California	Cedarville	Modoc	32.6	13.1	41614	0.017	6	Snowfall > 20 inches
06-061-0001	California	Auburn	Placer	1.2	35.3	40383	0.040	5	Precipitation >20 inches
06-071-1101	California	Twentynine Palms	San Bernardino	1.0	4.1	49099	0.049	11	Selected
06-083-1011	California	Jalama	Santa Barbara	0.0	14.6	45064	0.045	7	Selected
06-083-1012	California	Concepcion	Santa Barbara	0.0	14.6	45064	0.043	7	Duplicate with 06-083-1011
06-083-1015	California	Gaviota	Santa Barbara	0.0	14.6	45064	0.024	6	Duplicate with 06-083-1011
06-083-1016	California	Gaviota	Santa Barbara	0.0	14.6	45064	0.025	6	Duplicate with 06-083-1011
06-083-1017	California	Gaviota	Santa Barbara	0.0	14.6	45064	0.039	7	Duplicate with 06-083-1011

EPA Site ID	State	City	County	Inches 0 Snow-fall	 0 Precip-itation	Weather station	0 TSP (mg/m^3)	N Years	Comments
06-083-1019	California	Gaviota	Santa Barbara	0.0	14.6	45064	0.030	7	Duplicate with 06-083-1011
06-083-1020	California	Isla Vista	Santa Barbara	0.0	17.8	47902	0.043	6	Duplicate with 06-083-1011
06-083-1030	California	Concepcion	Santa Barbara	0.0	14.6	45064	0.038	6	Duplicate with 06-083-1011
06-083-4003	California	Vandenburg AFB	Santa Barbara	0.0	14.6	45064	0.031	7	Duplicate with 06-083-1011
06-083-5001	California	Vandenburg AFB	Santa Barbara	0.0	12.6	47946	0.037	3	Duplicate with 06-083-1011
06-089-1002	California	Burney	Shasta	50.6	27.5	41214	0.034	2	Precipitation >20 inches
06-103-1001	California	Los Molinos	Tehama	2.3	22.8	47292	0.047	8	Precipitation >20 inches
06-111-0004	California	Piru	Ventura	0.0	17.0	46940	0.047	7	Duplicate with 06-111-3001
06-111-0005	California	Oak View	Ventura	0.1	21.2	46399	0.038	5	Precipitation >20 inches
06-111-1101	California	Piru	Ventura	0.0	17.0	46940	0.064	2	Duplicate with 06-111-3001
06-111-3001	California	El Rio	Ventura	0.1	14.4	46569	0.064	13	Selected
06-113-4001	California	Dunnigan	Yolo	0.1	18.6	49781	0.044	13	Selected
06-115-0002	California	Smartsville	Yuba	10.2	53.2	43573	0.027	2	Precipitation >20 inches
16-001-0001	Idaho	Boise	Ada	20.9	11.9	101022	0.044	20	Snowfall > 20 inches
16-005-1003	Idaho	Pocatello	Bannock	41.8	11.8	107211	0.068	3	Snowfall > 20 inches
16-011-0001	Idaho	Grandview	Bingham	22.4	11.4	103297	0.049	1	Snowfall > 20 inches
16-029-0001	Idaho	Soda Springs	Caribou	43.8	16.1	108535	0.070	1	Snowfall > 20 inches
16-029-0002	Idaho	Conda	Caribou	95.0	22.1	104230	0.038	16	Precipitation >20 inches
16-053-0001	Idaho	Jerome	Jerome	23.2	10.3	104670	0.047	7	Snowfall > 20 inches
16-055-1002	Idaho	Coeur D'Alene	Kootenai	51.3	25.4	101956	0.052	8	Precipitation >20 inches
16-077-0005	Idaho	Pocotello	Power	41.8	11.8	107211	0.118	2	Snowfall > 20 inches
16-083-0003	Idaho	Twin Falls	Twin Falls	28.2	10.8	109303	0.047	3	Snowfall > 20 inches
16-083-0004	Idaho	Hansen	Twin Falls	28.2	10.8	109303	0.038	4	Snowfall > 20 inches
16-083-1001	Idaho	Twin Falls	Twin Falls	28.2	10.8	109303	0.045	3	Snowfall > 20 inches
32-003-1003	Nevada	Moapa	Clark	0.4	4.1	265846	0.061	1	Selected
32-031-1004	Nevada	Sparks	Washoe	6.9	8.1	267697	0.054	12	Selected
32-031-2003	Nevada	Wadsworth	Washoe	0.3	5.7	268838	0.041	3	Duplicate with 32-031-1004
35-013-0004	New Mexico	Sunland Park	Dona Ana	4.5	9.4	298535	0.080	17	Selected

				Inches					
EPA Site ID	State	City	County	0 Snow-fall	0 Precip-itation	Weather station	0 TSP (mg/m^3)	N Years	Comments
35-013-0006	New Mexico	Afton	Dona Ana	4.5	9.4	298535	0.045	3	Duplicate with 35-013-0004
35-013-0016	New Mexico	Anthony	Dona Ana	4.5	9.4	298535	0.137	2	Duplicate with 35-013-0004
35-017-0002	New Mexico	Hurley	Grant	10.0	15.8	293265	0.085	3	Selected
35-045-0013	New Mexico	La Plata	San Juan	7.8	8.8	293134	0.034	3	Duplicate with 35-045-0014
35-045-0014	New Mexico	Kirtland	San Juan	11.5	8.1	293340	0.044	14	Selected
35-045-0015	New Mexico		San Juan	16.4	10.1	290692	0.029	3	Duplicate with 35-045-0014
35-045-0021	New Mexico		San Juan	7.8	8.8	293134	0.036	1	Duplicate with 35-045-0014
35-061-0007 35-006-0007	New Mexico	Bluewater	Valencia/Cibola	14.8	10.8	293682	0.071	6	Selected. Data from 2 sites at same location were combined.
41-059-1001	Oregon	Pendelton	Umatilla	17.1	12.2	356546	0.040	5	Selected
49-015-0002	Utah	Hunington	Emery	17.8	7.7	421214	0.030	4	Selected
49-015-0003	Utah		Emery	17.8	7.7	421214	0.017	4	Duplicate with 49-015-0002
49-027-0002	Utah	Delta	Millard	25.2	7.8	422090	0.041	1	Snowfall > 20 inches
53-039-0002	Washington	Bingen	Klickitat	19.8	13.7	451968	0.056	4	Selected
53-071-1001	Washington	Wallula Junction	Walla Walla	7.7	10.1	453883	0.066	9	Selected
53-075-0002	Washington	Pullman	Whitman	28.3	21.5	456789	0.038	3	Precipitation >20 inches
53-077-0003	Washington	Sunnyside	Yakima	11.5	7.0	458207	0.062	10	Selected

Notes: DTN: MO0210SPATSP01.023 and NCDC 1998a,b

APPENDIX C. INFLUENCE OF CLIMATE CHANGE

This appendix documents a comparison of TSP concentrations in areas with lower and higher amounts of precipitation and snowfall to determine whether separate distributions of mass loading should be used for current and future climatic conditions.

Average annual precipitation at Yucca Mountain currently is about four to six inches (CRWMS M&O 1999b, Appendix A) and snowfall is rare. It is predicted that the future climate for most of the next 10,000 years will be similar to that currently found in parts of eastern Washington. Analog weather stations for the upper bound of the dominant future climate are Spokane (0 annual precipitation = 16.2 inches, 0 annual snowfall = 42.1 inches), Rosalia (0 precipitation = 18.1 inches, 0 snowfall = 24.3 inches), and St. Johns (0 precipitation = 17.1 inches, 0 snowfall = 25.8 inches), (USGS 2001, Table 2) (climate data are from NCDC 1998a,b).

To determine whether mass loading may differ due to a change in climate, average annual concentrations of TSP measured at rural, agricultural sites in the western United States were compared among sites with different amounts of precipitation and snowfall. The data used in this comparison were obtained from the EPA AirData database (DTN MO0210SPATSP01.023) and the U.S. National Climatic Data Center (NCDC 1988a,b) and are listed in Tables B-1 and B-2. See Section 6.1.2 for a description of how the data were obtained and processed. See Table B-2 for a description of each site. Because the sites have comparable land uses and settings, sources of resuspended particulate matter should be similar among sites.

To evaluate the influence of precipitation on concentrations of resuspended particles, the average TSP for sites with <10, 10 to 20, and >20 inches of precipitation per year was calculated (Table C-1). For this comparison, 25 duplicate sites within a county and 2 sites with conditions that may not be typical for rural agricultural settings were deleted from consideration (see Section 6.1.2). To evaluate the influence of snowfall, the average TSP for sites with <10, 10 to 20, and >20 inches of snowfall per year was calculated (Table C-2). To eliminate the influence of high precipitation, the ten sites listed in Table C-1 that have >20 inches of precipitation were not included in this analysis.

Average TSP concentrations differed little between 11 sites with <10 inches of precipitation (0 = 0.055, sd = 0.020) and 21 sites with 10 to 20 inches (0 = 0.056, sd = 0.023). Ten sites with >20 inches of precipitation per year had much lower concentrations (0 = 0.037, sd = 0.009). There was little difference in TSP concentrations among 14 sites with <10 inches of snowfall (0 = 0.058, sd = 0.020), 7 sites with 10 to 20 inches of snowfall (0 = 0.055, sd = 0.019), and 11 sites with >20 inches of snowfall (0 = 0.053, sd = 0.026).

Based on this analysis it is concluded that rural agricultural sites with less than 20 inches of precipitation and less than about 45 inches of snowfall have similar concentrations of resuspended particles; therefore, separate distributions of mass loading are not required for current and future climatic states.

Table C-1. Average Annual Snowfall (inches), Precipitation (inches), and TSP (mg/m^3) at Rural, Agricultural Sites in the Western United States with <10, 10–20, and >20 Inches of Precipitation.

<10 inches Precipitation				10–20 inches Precipitation				>20 inches Precipitation			
EPA Site ID	**Snow**	**Precip**	**TSP**	**EPA Site ID**	**Snow**	**Precip**	**TSP**	**EPA Site ID**	**Snow**	**Precip**	**TSP**
06-071-1101	1.0	4.1	0.049	53-071-1001	7.7	10.1	0.066	06-111-0005	0.1	21.2	0.038
32-003-1003	0.4	4.1	0.061	16-053-0001	23.2	10.3	0.047	53-075-0002	28.3	21.5	0.038
06-027-0002	8.0	5.3	0.025	35-061-0007	14.8	10.8	0.071	16-029-0002	95.0	22.1	0.038
06-019-1002	0.2	6.6	0.078	16-083-0003	28.2	10.8	0.047	06-103-1001	2.3	22.8	0.047
53-077-0003	11.5	7.0	0.062	16-083-0004	28.2	10.8	0.038	16-055-1002	51.3	25.4	0.052
06-031-1002	0.1	7.2	0.086	16-083-1001	28.2	10.8	0.045	06-089-1002	50.6	27.5	0.034
49-015-0002	17.8	7.7	0.030	16-011-0001	22.4	11.4	0.049	06-033-0002	0.5	29.1	0.034
49-027-0002	25.2	7.8	0.041	16-005-1003	41.8	11.8	0.068	06-033-0003	0.5	29.1	0.019
32-031-1004	6.9	8.1	0.054	16-077-0005	41.8	11.8	0.118	06-061-0001	1.2	35.3	0.040
35-045-0014	11.5	8.1	0.044	16-001-0001	20.9	11.9	0.044	06-115-0002	10.2	53.2	0.027
35-013-0004	4.5	9.4	0.080	41-059-1001	17.1	12.2	0.040			N =	10
		N =	11	06-013-1002	0.0	12.7	0.041			0 =	0.037
		0 =	0.055	06-049-1001	32.6	13.1	0.017			sd =	0.009
		sd =	0.020	53-039-0002	19.8	13.7	0.056				
				04-019-0010	0.0	13.9	0.089				
				06-111-3001	0.1	14.4	0.064				
				06-083-1012	0.0	14.6	0.043				
				35-017-0002	10.0	15.8	0.085				
				16-029-0001	43.8	16.1	0.070				
				06-113-4001	0.1	18.6	0.044				
				04-007-1902	2.9	19.3	0.030				
						N =	21				
						0 =	0.056				
						sd =	0.023				

Notes: DTN MO0210SPATSP01.023 and NCDC 1998a,b (see Table B-2 for list of data).

Table C-2. Average Annual Snowfall (inches), Precipitation (inches), and TSP (mg/m^3) at Rural, Agricultural Sites in the Western United States with <10, 10–20, and >20 Inches of Snowfall.

<10 inches Snowfall				10–20 inches Snowfall				>20 inches Snowfall			
EPA Site ID	**Snow**	**Precip**	**TSP**	**EPA Site ID**	**Snow**	**Precip**	**TSP**	**EPA Site ID**	**Snow**	**Precip**	**TSP**
06-013-1002	0.0	12.7	0.041	35-017-0002	10.0	15.8	0.085	16-001-0001	20.9	11.9	0.044
04-019-0010	0.0	13.9	0.089	35-045-0014	11.5	8.1	0.044	16-011-0001	22.4	11.4	0.049
06-083-1012	0.0	14.6	0.043	53-077-0003	11.5	7.0	0.062	16-053-0001	23.2	10.3	0.047
06-031-1002	0.1	7.2	0.086	35-061-0007	14.8	10.8	0.071	49-027-0002	25.2	7.8	0.041
06-111-3001	0.1	14.4	0.064	41-059-1001	17.1	12.2	0.040	16-083-0003	28.2	10.8	0.047
06-113-4001	0.1	18.6	0.044	49-015-0002	17.8	7.7	0.030	16-083-0004	28.2	10.8	0.038
06-019-1002	0.2	6.6	0.078	53-039-0002	19.8	13.7	0.056	16-083-1001	28.2	10.8	0.045
32-003-1003	0.4	4.1	0.061			N =	7	06-049-1001	32.6	13.1	0.017
06-071-1101	1.0	4.1	0.049			0 =	0.055	16-005-1003	41.8	11.8	0.068
04-007-1902	2.9	19.3	0.030			sd =	0.019	16-077-0005	41.8	11.8	0.118
35-013-0004	4.5	9.4	0.080					16-029-0001	43.8	16.1	0.070
32-031-1004	6.9	8.1	0.054							N =	11
53-071-1001	7.7	10.1	0.066							0 =	0.053
06-027-0002	8.0	5.3	0.025							sd =	0.026
		N =	14								
		0 =	0.058								
		sd =	0.020								

Notes: DTN MO0210SPATSP01.023 and NCDC 1998a,b (see Table B-2 for list of data).

APPENDIX D. TSP CONCENTRATIONS–MOUNT ST. HELENS, 1979–1982

Table D-1 contains measurements of 24-hour concentrations of TSP taken at Clarkston, Richland, and Longview, Washington, during 1979 through 1982. Table D-2 contain TSP measurements for the same period from Spokane, Vancouver, and Yakima, Washington. The data were obtained from the EPA AirData database (DTN: MO0008SPATSP00.013). The running average is the average of the measurements for a day and the four previous measurements.

Table D-1. Twenty-four hour and running average concentrations (mg/m^3) of TSP at Clarkston, Richland, and Longview, Washington, 1979–1982.

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	TSP	0[a]	Date	TSP	0[a]	Date	TSP	0[a]
9/25/79	0.221		1/3/79	0.072		1/15/79	0.116	
9/27/79	0.212		1/9/79	0.059		1/21/79	0.074	
9/30/79	0.096		1/15/79	0.043		1/27/79	0.074	
10/6/79	0.172		1/21/79	0.046		2/2/79	0.128	
10/9/79	0.155	0.1712	1/27/79	0.066	0.0572	2/8/79	0.054	0.089
10/12/79	0.203	0.1676	2/2/79	0.102	0.0632	2/14/79	0.089	0.084
10/16/79	0.066	0.1384	2/8/79	0.037	0.0588	2/22/79	0.020	0.073
10/18/79	0.063	0.1318	2/14/79	0.043	0.0588	2/26/79	0.040	0.066
10/21/79	0.023	0.102	2/20/79	0.042	0.058	3/4/79	0.032	0.047
10/24/79	0.047	0.0804	2/26/79	0.031	0.051	3/10/79	0.100	0.056
10/27/79	0.076	0.055	3/4/79	0.03	0.0366	3/16/79	0.062	0.051
10/30/79	0.078	0.0574	3/10/79	0.067	0.0426	3/22/79	0.092	0.065
11/1/79	0.079	0.0606	3/16/79	0.043	0.0426	3/28/79	0.037	0.065
11/6/79	0.069	0.0698	3/22/79	0.1	0.0542	4/3/79	0.050	0.068
11/8/79	0.107	0.0818	3/28/79	0.038	0.0556	4/9/79	0.023	0.053
11/11/79	0.083	0.0832	4/3/79	0.066	0.0628	4/15/79	0.025	0.045
11/14/79	0.074	0.0824	4/9/79	0.036	0.0566	4/21/79	0.041	0.035
11/17/79	0.074	0.0814	4/15/79	0.053	0.0586	4/27/79	0.057	0.039
11/20/79	0.087	0.085	4/25/79	0.03	0.0446	5/3/79	0.055	0.040
11/23/79	0.044	0.0724	4/27/79	0.069	0.0508	5/9/79	0.029	0.041
11/28/79	0.058	0.0674	5/3/79	0.072	0.052	5/15/79	0.021	0.041
12/2/79	0.069	0.0664	5/9/79	0.059	0.0566	5/21/79	0.051	0.043
12/8/79	0.078	0.0672	5/15/79	0.101	0.0662	5/27/79	0.029	0.037
12/11/79	0.108	0.0714	5/21/79	0.097	0.0796	6/2/79	0.044	0.035
12/13/79	0.101	0.0828	5/27/79	0.061	0.078	6/8/79	0.038	0.037
12/17/79	0.047	0.0806	6/2/79	0.079	0.0794	6/14/79	0.039	0.040
12/20/79	0.121	0.091	6/8/79	0.093	0.0862	6/20/79	0.008	0.032
12/23/79	0.079	0.0912	6/14/79	0.065	0.079	6/26/79	0.037	0.033
12/27/79	0.064	0.0824	6/20/79	0.043	0.0682	7/2/79	0.027	0.030
12/29/79	0.059	0.074	6/26/79	0.333	0.1226	7/8/79	0.025	0.027
1/4/80	0.065	0.0776	7/2/79	0.063	0.1194	7/14/79	0.025	0.024
1/8/80	0.033	0.06	7/8/79	0.055	0.1118	7/20/79	0.047	0.032
1/13/80	0.062	0.0566	7/14/79	0.089	0.1166	7/26/79	0.031	0.031
1/15/80	0.095	0.0628	7/20/79	0.126	0.1332	8/1/79	0.024	0.030
1/17/80	0.068	0.0646	7/26/79	0.25	0.1166	8/7/79	0.034	0.032
1/19/80	0.157	0.083	8/1/79	0.116	0.1272	8/13/79	0.033	0.034
1/22/80	0.097	0.0958	8/7/79	0.141	0.1444	8/19/79	0.013	0.027

Table D-1. Continued

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	TSP	0[a]	Date	TSP	0[a]	Date	TSP	0[a]
1/24/80	0.093	0.102	8/13/79	0.191	0.1648	8/25/79	0.023	0.025
1/28/80	0.082	0.0994	8/19/79	0.082	0.156	8/31/79	0.026	0.026
1/30/80	0.145	0.1148	8/25/79	0.072	0.1204	9/6/79	0.040	0.027
2/3/80	0.086	0.1006	8/31/79	0.051	0.1074	9/12/79	0.049	0.030
2/6/80	0.073	0.0958	9/6/79	0.068	0.0928	9/18/79	0.059	0.039
2/9/80	0.083	0.0938	9/12/79	0.09	0.0726	9/24/79	0.072	0.049
2/12/80	0.068	0.091	9/18/79	0.112	0.0786	9/30/79	0.038	0.052
2/15/80	0.077	0.0774	9/24/79	0.116	0.0874	10/6/79	0.064	0.056
2/20/80	0.08	0.0762	9/30/79	0.066	0.0904	10/12/79	0.098	0.066
2/22/80	0.154	0.0924	10/6/79	0.143	0.1054	10/18/79	0.034	0.061
2/26/80	0.071	0.09	10/12/79	0.146	0.1166	10/24/79	0.037	0.054
2/28/80	0.058	0.088	10/18/79	0.041	0.1024	10/30/79	0.036	0.054
3/1/80	0.093	0.0912	10/24/79	0.027	0.0846	11/5/79	0.027	0.046
3/4/80	0.041	0.0834	10/30/79	0.037	0.0788	11/11/79	0.046	0.036
3/6/80	0.059	0.0644	11/5/79	0.02	0.0542	11/29/79	0.069	0.043
3/28/80	0.082	0.0666	11/14/79	0.031	0.0312	12/5/79	0.062	0.048
4/1/80	0.073	0.0696	11/17/79	0.031	0.0292	12/11/79	0.034	0.048
4/3/80	0.056	0.0622	11/23/79	0.024	0.0286	12/17/79	0.052	0.053
4/6/80	0.047	0.0634	11/29/79	0.038	0.0288	12/23/79	0.026	0.049
4/8/80	0.068	0.0652	12/5/79	0.009	0.0266	12/29/79	0.160	0.067
4/12/80	0.094	0.0676	12/19/79	0.037	0.0278	1/16/80	0.066	0.068
4/15/80	0.071	0.0672	12/23/79	0.02	0.0256	1/22/80	0.187	0.098
4/17/80	0.144	0.0848	12/29/79	0.018	0.0244	1/28/80	0.222	0.132
4/21/80	0.054	0.0862	1/4/80	0.023	0.0214	2/3/80	0.080	0.143
4/24/80	0.129	0.0984	1/16/80	0.005	0.0206	2/9/80	0.157	0.142
4/27/80	0.113	0.1022	1/18/80	0.022	0.0176	2/15/80	0.085	0.146
4/30/80	0.037	0.0954	1/22/80	0.049	0.0234	2/21/80	0.075	0.124
5/3/80	0.081	0.0828	1/31/80	0.038	0.0274	2/27/80	0.052	0.090
5/6/80	0.043	0.0806	2/3/80	0.039	0.0306	3/4/80	0.072	0.088
5/9/80	0.029	0.0606	2/9/80	0.024	0.0344	3/16/80	0.036	0.064
5/13/80	0.061	0.0502	2/15/80	0.051	0.0402	3/22/80	0.048	0.057
5/15/80	0.032	0.0492	2/21/80	0.025	0.0354	3/28/80	0.061	0.054
5/18/80	0.678	0.1686	2/27/80	0.017	0.0312	4/3/80	0.107	0.065
5/21/80	0.601	0.2802	3/4/80	0.024	0.0282	4/9/80	0.026	0.056
5/24/80	0.423	0.359	3/13/80	0.028	0.029	4/15/80	0.035	0.055
6/2/80	0.089	0.3646	3/16/80	0.022	0.0232	4/21/80	0.037	0.053
6/20/80	0.149	0.388	3/22/80	0.095	0.0372	4/27/80	0.066	0.054
6/24/80	0.062	0.2648	3/28/80	0.033	0.0404	5/3/80	0.050	0.043
6/26/80	0.044	0.1534	4/3/80	0.057	0.047	5/9/80	0.026	0.043
6/29/80	0.094	0.0876	4/9/80	0.202	0.0818	5/15/80	0.036	0.043
7/2/80	0.076	0.085	4/21/80	0.017	0.0808	5/21/80	0.017	0.039
7/14/80	0.05	0.0652	4/27/80	0.065	0.0748	5/27/80	1.420	0.310
7/23/80	0.526	0.158	5/3/80	0.067	0.0816	6/2/80	0.526	0.405
8/1/80	0.147	0.1786	5/9/80	0.023	0.0748	6/8/80	0.986	0.597
8/4/80	0.089	0.1776	5/15/80	0.05	0.0444	6/14/80	0.071	0.604
8/7/80	0.128	0.188	5/23/80	0.611	0.1632	6/26/80	0.168	0.634
8/13/80	0.167	0.2114	5/29/80	0.099	0.17	7/2/80	0.143	0.379
8/16/80	0.133	0.1328	6/2/80	0.083	0.1732	7/8/80	0.097	0.293
8/19/80	0.054	0.1142	6/10/80	0.109	0.1904	7/14/80	0.053	0.106
8/21/80	0.085	0.1134	6/14/80	0.049	0.1902	7/20/80	0.106	0.113

Table D-1. Continued

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	TSP	0^a	Date	TSP	0^a	Date	TSP	0^a
8/25/80	0.102	0.1082	6/20/80	0.093	0.0866	7/26/80	0.067	0.093
8/27/80	0.104	0.0956	6/26/80	0.074	0.0816	8/1/80	0.044	0.073
8/31/80	0.039	0.0768	7/2/80	0.091	0.0832	8/7/80	0.181	0.090
9/6/80	0.119	0.0898	7/8/80	0.133	0.088	8/13/80	0.046	0.089
9/10/80	0.109	0.0946	7/14/80	0.15	0.1082	8/19/80	0.054	0.078
9/12/80	0.106	0.0954	7/20/80	0.065	0.1026	8/25/80	0.048	0.075
9/16/80	0.077	0.09	7/26/80	0.181	0.124	8/31/80	0.025	0.071
9/18/80	0.087	0.0996	8/1/80	0.171	0.14	9/6/80	0.056	0.046
9/22/80	0.076	0.091	8/7/80	0.077	0.1288	9/12/80	0.036	0.044
9/24/80	0.091	0.0874	8/13/80	0.128	0.1244	9/18/80	0.055	0.044
9/28/80	0.094	0.085	8/19/80	0.103	0.132	9/24/80	0.093	0.053
9/30/80	0.144	0.0984	8/25/80	0.081	0.112	9/30/80	0.053	0.059
10/7/80	0.18	0.117	9/6/80	0.091	0.096	10/6/80	0.062	0.060
10/9/80	0.182	0.1382	9/12/80	0.071	0.0948	10/12/80	0.077	0.068
10/12/80	0.105	0.141	9/18/80	0.085	0.0862	10/18/80	0.119	0.081
10/15/80	0.055	0.1332	9/24/80	0.086	0.0828	10/24/80	0.118	0.086
10/18/80	0.114	0.1272	9/30/80	0.076	0.0818	10/30/80	0.103	0.096
10/21/80	0.114	0.114	10/7/80	0.146	0.0928	11/5/80	0.059	0.095
10/24/80	0.13	0.1036	10/12/80	0.049	0.0884	11/11/80	0.078	0.095
10/28/80	0.123	0.1072	10/18/80	0.094	0.0902	11/17/80	0.037	0.079
10/30/80	0.148	0.1258	10/24/80	0.075	0.088	11/23/80	0.078	0.071
11/2/80	0.063	0.1156	10/30/80	0.052	0.0832	11/29/80	0.026	0.056
11/5/80	0.139	0.1206	11/5/80	0.033	0.0606	12/5/80	0.040	0.052
11/7/80	0.049	0.1044	11/11/80	0.025	0.0558	12/11/80	0.088	0.054
11/11/80	0.04	0.0878	11/17/80	0.037	0.0444	12/17/80	0.028	0.052
11/13/80	0.082	0.0746	11/23/80	0.023	0.034	12/23/80	0.046	0.046
11/17/80	0.143	0.0906	11/29/80	0.048	0.0332	12/29/80	0.055	0.051
11/20/80	0.075	0.0778	12/5/80	0.019	0.0304	1/4/81	0.145	0.072
11/23/80	0.052	0.0784	12/11/80	0.046	0.0346	1/10/81	0.182	0.091
11/25/80	0.086	0.0876	12/17/80	0.013	0.0298	1/16/81	0.133	0.112
11/29/80	0.048	0.0808	12/23/80	0.022	0.0296	1/22/81	0.053	0.114
12/3/80	0.105	0.0732	12/29/80	0.028	0.0256	1/28/81	0.065	0.116
12/9/80	0.133	0.0848	1/4/81	0.028	0.0274	2/3/81	0.110	0.109
12/11/80	0.08	0.0904	1/10/81	0.015	0.0212	2/9/81	0.066	0.085
12/14/80	0.102	0.0936	1/16/81	0.027	0.024	2/15/81	0.027	0.064
12/18/80	0.036	0.0912	1/22/81	0.031	0.0258	2/21/81	0.106	0.075
12/20/80	0.065	0.0832	1/28/81	0.009	0.022	2/27/81	0.103	0.082
12/23/80	0.175	0.0916	2/3/81	0.024	0.0212	3/5/81	0.095	0.079
12/29/80	0.081	0.0918	2/9/81	0.08	0.0342	3/11/81	0.066	0.079
1/4/81	0.073	0.086	2/15/81	0.014	0.0316	3/17/81	0.065	0.087
1/11/81	0.109	0.1006	2/21/81	0.024	0.0302	3/23/81	0.040	0.074
1/16/81	0.072	0.102	2/27/81	0.024	0.0332	3/29/81	0.028	0.059
1/22/81	0.08	0.083	3/5/81	0.023	0.033	4/4/81	0.052	0.050
2/3/81	0.085	0.0838	3/11/81	0.086	0.0342	4/10/81	0.036	0.044
2/9/81	0.047	0.0786	3/17/81	0.043	0.04	4/16/81	0.041	0.039
2/15/81	0.055	0.0678	3/23/81	0.052	0.0456	4/22/81	0.021	0.036
2/21/81	0.097	0.0728	3/29/81	0.073	0.0554	5/22/81	0.038	0.038
2/27/81	0.118	0.0804	4/4/81	0.046	0.06	5/28/81	0.053	0.038
3/5/81	0.059	0.0752	4/10/81	0.036	0.05	6/3/81	0.046	0.040
3/11/81	0.123	0.0904	4/16/81	0.038	0.049	6/9/81	0.026	0.037

Table D-1. Continued

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	TSP	0^{a}	Date	TSP	0^{a}	Date	TSP	0^{a}
3/17/81	0.046	0.0886	4/22/81	0.057	0.05	6/15/81	0.048	0.042
3/23/81	0.053	0.0798	4/28/81	0.066	0.0486	6/21/81	0.021	0.039
3/29/81	0.025	0.0612	5/4/81	0.052	0.0498	7/15/81	0.050	0.038
4/10/81	0.053	0.06	5/10/81	0.072	0.057	7/21/81	0.018	0.033
4/16/81	0.074	0.0502	5/16/81	0.037	0.0568	7/27/81	0.052	0.038
4/22/81	0.055	0.052	5/22/81	0.046	0.0546	8/2/81	0.028	0.034
4/28/81	0.066	0.0546	5/28/81	0.064	0.0542	8/8/81	0.071	0.044
5/5/81	0.046	0.0588	6/3/81	0.065	0.0568	8/14/81	0.044	0.043
5/10/81	0.033	0.0548	6/9/81	0.024	0.0472	8/20/81	0.034	0.046
5/22/81	0.039	0.0478	6/15/81	0.046	0.049	8/26/81	0.048	0.045
5/28/81	0.097	0.0562	6/21/81	0.041	0.048	9/1/81	0.019	0.043
6/3/81	0.063	0.0556	6/27/81	0.061	0.0474	9/7/81	0.098	0.049
6/9/81	0.028	0.052	7/3/81	0.111	0.0566	9/13/81	0.054	0.051
6/15/81	0.053	0.056	7/9/81	0.064	0.0646	9/19/81	0.036	0.051
6/21/81	0.032	0.0546	7/15/81	0.083	0.072	9/25/81	0.037	0.049
6/27/81	0.078	0.0508	7/21/81	0.084	0.0806	10/1/81	0.053	0.056
7/3/81	0.065	0.0512	7/27/81	0.08	0.0844	10/7/81	0.025	0.041
7/9/81	0.058	0.0572	8/2/81	0.102	0.0826	10/13/81	0.062	0.043
7/15/81	0.066	0.0598	8/8/81	0.107	0.0912	10/19/81	0.025	0.040
7/21/81	0.092	0.0718	8/20/81	0.068	0.0882	10/25/81	0.076	0.048
7/27/81	0.081	0.0724	8/23/81	0.098	0.091	10/31/81	0.083	0.054
8/2/81	0.097	0.0788	8/26/81	0.099	0.0948	11/6/81	0.161	0.081
8/8/81	0.111	0.0894	9/1/81	0.085	0.0914	11/12/81	0.038	0.077
8/15/81	0.108	0.0978	9/7/81	0.077	0.0854	11/18/81	0.059	0.083
8/20/81	0.123	0.104	9/13/81	0.094	0.0906	11/24/81	0.103	0.089
8/26/81	0.139	0.1156	9/19/81	0.057	0.0824	12/6/81	0.041	0.080
9/1/81	0.278	0.1518	9/25/81	0.04	0.0706	12/12/81	0.064	0.061
9/7/81	0.126	0.1548	10/1/81	0.041	0.0618	12/18/81	0.048	0.063
9/13/81	0.108	0.1548	10/7/81	0.02	0.0504	12/24/81	0.033	0.058
9/19/81	0.191	0.1684	10/13/81	0.05	0.0416	12/30/81	0.059	0.049
9/26/81	0.048	0.1502	10/19/81	0.066	0.0434	1/5/82	0.069	0.055
10/1/81	0.083	0.1112	10/25/81	0.083	0.052	1/11/82	0.088	0.059
10/8/81	0.056	0.0972	10/31/81	0.036	0.051	1/17/82	0.028	0.055
10/14/81	0.121	0.0998	11/12/81	0.023	0.0516	1/23/82	0.024	0.054
10/21/81	0.118	0.0852	11/18/81	0.011	0.0438	1/29/82	0.053	0.052
10/25/81	0.159	0.1074	11/24/81	0.024	0.0354	2/4/82	0.156	0.070
10/31/81	0.041	0.099	11/30/81	0.017	0.0222	2/10/82	0.122	0.077
11/6/81	0.134	0.1146	12/6/81	0.012	0.0174	2/16/82	0.030	0.077
11/12/81	0.044	0.0992	12/12/81	0.016	0.016	2/22/82	0.035	0.079
11/18/81	0.032	0.082	12/24/81	0.032	0.0202	2/28/82	0.063	0.081
11/24/81	0.047	0.0596	12/30/81	0.025	0.0204	3/6/82	0.058	0.062
11/30/81	0.032	0.0578	1/5/82	0.033	0.0236	3/12/82	0.049	0.047
12/6/81	0.127	0.0564	1/11/82	0.052	0.0316	3/18/82	0.086	0.058
12/12/81	0.104	0.0684	1/17/82	0.012	0.0308	3/24/82	0.075	0.066
12/19/81	0.048	0.0716	1/23/82	0.029	0.0302	4/5/82	0.026	0.059
12/24/81	0.036	0.0694	1/29/82	0.019	0.029	4/11/82	0.031	0.053
12/30/81	0.061	0.0752	2/4/82	0.032	0.0288	4/17/82	0.049	0.053
1/5/82	0.069	0.0636	2/10/82	0.038	0.026	4/23/82	0.051	0.046
1/11/82	0.067	0.0562	2/16/82	0.021	0.0278	4/29/82	0.056	0.043
1/17/82	0.057	0.058	2/22/82	0.015	0.025	5/5/82	0.071	0.052

Table D-1. Continued

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	**TSP**	0[a]	**Date**	**TSP**	0[a]	**Date**	**TSP**	0[a]
1/23/82	0.031	0.057	2/28/82	0.02	0.0252	5/11/82	0.029	0.051
2/4/82	0.07	0.0588	3/6/82	0.035	0.0258	5/17/82	0.029	0.047
2/10/82	0.084	0.0618	3/12/82	0.067	0.0316	5/23/82	0.045	0.046
2/17/82	0.081	0.0646	3/18/82	0.044	0.0362	5/29/82	0.064	0.048
2/22/82	0.071	0.0674	3/24/82	0.066	0.0464	6/4/82	0.047	0.043
2/28/82	0.065	0.0742	3/30/82	0.027	0.0478	6/10/82	0.064	0.050
3/6/82	0.073	0.0748	4/5/82	0.023	0.0454	6/16/82	0.096	0.063
3/12/82	0.095	0.077	4/11/82	0.016	0.0352	6/22/82	0.041	0.062
4/18/82	0.09	0.0788	4/17/82	0.091	0.0446	6/28/82	0.025	0.055
4/24/82	0.101	0.0848	4/23/82	0.083	0.048	7/4/82	0.031	0.051
4/30/82	0.099	0.0916	4/29/82	0.04	0.0506	7/10/82	0.028	0.044
5/6/82	0.104	0.0978	5/5/82	0.053	0.0566	7/16/82	0.029	0.031
5/12/82	0.095	0.0978	5/11/82	0.057	0.0648	7/22/82	0.044	0.031
5/17/82	0.064	0.0926	5/17/82	0.029	0.0524	7/28/82	0.044	0.035
5/29/82	0.062	0.0848	5/23/82	0.053	0.0464	8/3/82	0.031	0.035
6/10/82	0.072	0.0794	5/29/82	0.046	0.0476	8/9/82	0.023	0.034
6/16/82	0.104	0.0794	6/4/82	0.096	0.0562	8/15/82	0.039	0.036
6/22/82	0.059	0.0722	6/10/82	0.084	0.0616	8/21/82	0.049	0.037
6/28/82	0.045	0.0684	6/16/82	0.062	0.0682	8/27/82	0.041	0.037
7/16/82	0.036	0.0632	6/22/82	0.056	0.0688	9/2/82	0.068	0.044
7/22/82	0.098	0.0684	7/10/82	0.054	0.0704	9/8/82	0.045	0.048
7/28/82	0.075	0.0626	7/16/82	0.031	0.0574	9/14/82	0.051	0.051
7/30/82	0.129	0.0766	7/22/82	0.063	0.0532	9/20/82	0.031	0.047
8/3/82	0.04	0.0756	7/26/82	0.094	0.0596	9/26/82	0.038	0.047
8/9/82	0.129	0.0942	7/28/82	0.087	0.0658	10/2/82	0.041	0.041
8/15/82	0.034	0.0814	8/3/82	0.041	0.0632	10/8/82	0.048	0.042
8/21/82	0.072	0.0808	8/9/82	0.146	0.0862	10/14/82	0.130	0.058
8/27/82	0.16	0.087	8/15/82	0.031	0.0798	10/20/82	0.135	0.078
9/8/82	0.135	0.106	8/21/82	0.077	0.0764	10/26/82	0.040	0.079
9/14/82	0.036	0.0874	8/27/82	0.085	0.076	11/1/82	0.107	0.092
9/20/82	0.036	0.0878	9/2/82	0.121	0.092	11/7/82	0.115	0.105
9/26/82	0.018	0.077	9/8/82	0.073	0.0774	11/13/82	0.072	0.094
10/2/82	0.076	0.0602	9/14/82	0.065	0.0842	11/19/82	0.054	0.078
10/8/82	0.051	0.0434	9/20/82	0.014	0.0716	11/25/82	0.097	0.089
10/14/82	0.122	0.0606	9/26/82	0.017	0.058	12/1/82	0.046	0.077
10/20/82	0.108	0.075	10/2/82	0.041	0.042	12/7/82	0.065	0.067
10/26/82	0.039	0.0792	10/8/82	0.034	0.0342	12/13/82	0.060	0.064
11/1/82	0.053	0.0746	10/14/82	0.081	0.0374	12/19/82	0.046	0.063
11/7/82	0.046	0.0736	10/20/82	0.087	0.052	12/25/82	0.050	0.053
11/13/82	0.042	0.0576	10/26/82	0.032	0.055	12/31/82	0.139	0.072
11/19/82	0.065	0.049	11/1/82	0.018	0.0504			
11/25/82	0.051	0.0514	11/7/82	0.011	0.0458			
12/1/82	0.057	0.0522	11/13/82	0.027	0.035			
12/7/82	0.034	0.0498	11/19/82	0.01	0.0196			
			11/25/82	0.026	0.0184			
			12/1/82	0.023	0.0194			
			12/7/82	0.019	0.021			
			12/13/82	0.024	0.0204			
			12/19/82	0.011	0.0206			
			12/25/82	0.033	0.022			

Table D-1. Continued

Clarkston (53-003-0003)			Richland (53-005-1001)			Longview (53-015-0008)		
Date	**TSP**	**0[a]**	**Date**	**TSP**	**0[a]**	**Date**	**TSP**	**0[a]**
			12/31/82	0.018	0.021			

Notes: DTN: MO008SPATSP00.013

[a] Running average of the measurement for a day and the four previous measurements.

Table D-2. Twenty-four hour and running average concentrations (mg/m^3) of TSP at Spokane, Vancouver, and Yakima, Washington, 1979–1982.

Spokane (53-063-0016)			Vancouver (53-011-0006)			Yakima (53-77-1006)		
Date	TSP	0[a]	Date	TSP	0[a]	Date	TSP	0[a]
1/3/79	0.146		1/3/79	0.072		1/3/79	0.083	
1/9/79	0.122		1/9/79	0.025		1/9/79	0.103	
1/15/79	0.106		1/15/79	0.159		1/15/79	0.048	
1/21/79	0.055		1/21/79	0.041		1/21/79	0.026	
1/27/79	0.121	0.110	1/27/79	0.034	0.0662	1/27/79	0.117	0.075
2/2/79	0.100	0.101	2/2/79	0.096	0.071	2/2/79	0.183	0.095
2/8/79	0.044	0.085	2/8/79	0.016	0.0692	2/8/79	0.038	0.082
2/14/79	0.210	0.106	2/14/79	0.048	0.047	2/14/79	0.048	0.082
2/21/79	0.045	0.104	2/20/79	0.039	0.0466	2/21/79	0.022	0.082
2/27/79	0.026	0.085	2/26/79	0.016	0.043	2/26/79	0.026	0.063
3/4/79	0.028	0.071	3/4/79	0.019	0.0276	3/4/79	0.059	0.039
3/10/79	0.233	0.108	3/10/79	0.067	0.0378	3/10/79	0.067	0.044
3/16/79	0.060	0.078	3/16/79	0.031	0.0344	3/16/79	0.036	0.042
3/23/79	0.285	0.126	3/22/79	0.094	0.0454	3/22/79	0.115	0.061
3/28/79	0.093	0.140	3/28/79	0.039	0.05	3/28/79	0.057	0.067
4/9/79	0.133	0.161	4/3/79	0.019	0.05	4/9/79	0.094	0.074
4/15/79	0.082	0.131	4/9/79	0.047	0.046	4/15/79	0.027	0.066
4/21/79	0.141	0.147	4/15/79	0.018	0.0434	5/5/79	0.045	0.068
4/27/79	0.230	0.136	4/21/79	0.057	0.036	5/9/79	0.063	0.057
5/3/79	0.188	0.155	4/27/79	0.075	0.0432	5/15/79	0.119	0.070
5/9/79	0.140	0.156	5/3/79	0.055	0.0504	5/17/79	0.119	0.075
5/15/79	0.210	0.182	5/9/79	0.025	0.046	5/21/79	0.098	0.089
5/21/79	0.173	0.188	5/15/79	0.083	0.059	5/27/79	0.073	0.094
5/27/79	0.054	0.153	5/21/79	0.089	0.0654	6/2/79	0.084	0.099
6/8/79	0.126	0.141	5/27/79	0.03	0.0564	6/8/79	0.059	0.087
6/14/79	0.126	0.138	6/2/79	0.108	0.067	6/14/79	0.048	0.072
6/20/79	0.116	0.119	6/8/79	0.083	0.0786	6/20/79	0.043	0.061
6/26/79	0.234	0.131	6/14/79	0.055	0.073	6/26/79	0.067	0.060
7/2/79	0.089	0.138	6/20/79	0.053	0.0658	7/2/79	0.037	0.051
7/8/79	0.129	0.139	6/26/79	0.083	0.0764	7/8/79	0.040	0.047
7/14/79	0.125	0.139	7/2/79	0.046	0.064	7/14/79	0.039	0.045
7/20/79	0.195	0.154	7/8/79	0.051	0.0576	7/20/79	0.083	0.053
7/26/79	0.209	0.149	7/14/79	0.072	0.061	7/26/79	0.075	0.055
8/7/79	0.262	0.184	7/20/79	0.057	0.0618	8/1/79	0.059	0.059
8/13/79	0.366	0.231	7/26/79	0.067	0.0586	8/7/79	0.068	0.065
8/19/79	0.091	0.225	8/1/79	0.043	0.058	8/13/79	0.259	0.109
8/25/79	0.123	0.210	8/7/79	0.054	0.0586	8/19/79	0.020	0.096
8/31/79	0.082	0.185	8/13/79	0.049	0.054	8/25/79	0.042	0.090
9/6/79	0.165	0.165	8/19/79	0.015	0.0456	8/31/79	0.027	0.083
9/12/79	0.235	0.139	8/25/79	0.045	0.0412	9/6/79	0.055	0.081
9/18/79	0.281	0.177	8/31/79	0.041	0.0408	9/12/79	0.094	0.048
9/24/79	0.307	0.214	9/6/79	0.044	0.0388	9/18/79	0.151	0.074
9/30/79	0.122	0.222	9/12/79	0.064	0.0418	9/24/79	0.115	0.088
10/6/79	0.277	0.244	9/18/79	0.104	0.0596	9/30/79	0.062	0.095
10/12/79	0.315	0.260	9/24/79	0.11	0.0726	10/6/79	0.099	0.104
10/18/79	0.105	0.225	9/30/79	0.061	0.0766	10/12/79	0.100	0.105

Table D-2. Continued

Spokane (53-063-0016)			Vancouver (53-011-0006)			Yakima (53-77-1006)		
Date	**TSP**	0[a]	**Date**	**TSP**	0[a]	**Date**	**TSP**	0[a]
10/24/79	0.081	0.180	10/6/79	0.112	0.0902	10/18/79	0.050	0.085
10/30/79	0.193	0.194	10/12/79	0.158	0.109	10/24/79	0.023	0.067
11/11/79	0.214	0.182	10/18/79	0.028	0.0938	10/30/79	0.041	0.063
11/17/79	0.055	0.130	10/24/79	0.015	0.0748	11/5/79	0.011	0.045
11/23/79	0.046	0.118	10/30/79	0.021	0.0668	11/11/79	0.015	0.028
11/29/79	0.315	0.165	11/5/79	0.012	0.0468	11/17/79	0.046	0.027
12/5/79	0.036	0.133	11/11/79	0.069	0.029	11/23/79	0.062	0.035
12/11/79	0.123	0.115	11/17/79	0.027	0.0288	11/29/79	0.080	0.043
12/17/79	0.092	0.122	11/23/79	0.019	0.0296	12/5/79	0.027	0.046
12/23/79	0.090	0.131	11/29/79	0.018	0.029	12/11/79	0.053	0.054
12/29/79	0.221	0.112	12/5/79	0.053	0.0372	12/17/79	0.032	0.051
1/4/80	0.132	0.132	12/11/79	0.038	0.031	12/23/79	0.013	0.041
1/10/80	0.074	0.122	12/17/79	0.016	0.0288	12/29/79	0.035	0.032
1/16/80	0.048	0.113	12/23/79	0.005	0.026	1/4/80	0.036	0.034
1/22/80	0.375	0.170	12/29/79	0.04	0.0304	1/10/80	0.062	0.036
1/28/80	0.357	0.197	1/4/80	0.03	0.0258	1/16/80	0.057	0.041
2/3/80	0.047	0.180	1/10/80	0.038	0.0258	1/22/80	0.074	0.053
2/9/80	0.120	0.189	1/16/80	0.026	0.0278	1/28/80	0.029	0.052
2/15/80	0.229	0.226	1/22/80	0.082	0.0432	2/3/80	0.055	0.055
2/21/80	0.297	0.210	1/28/80	0.03	0.0412	2/9/80	0.020	0.047
2/27/80	0.142	0.167	2/3/80	0.054	0.046	2/15/80	0.020	0.040
3/4/80	0.178	0.193	2/9/80	0.021	0.0426	2/21/80	0.016	0.028
3/10/80	0.113	0.192	2/15/80	0.04	0.0454	2/27/80	0.011	0.024
3/16/80	0.041	0.154	2/21/80	0.053	0.0396	3/4/80	0.076	0.029
3/22/80	0.163	0.127	2/27/80	0.022	0.038	3/10/80	0.055	0.036
3/28/80	0.145	0.128	3/4/80	0.047	0.0366	3/16/80	0.013	0.034
4/3/80	0.261	0.145	3/10/80	0.042	0.0408	3/22/80	0.101	0.051
4/9/80	0.063	0.135	3/16/80	0.018	0.0364	3/28/80	0.051	0.059
4/15/80	0.197	0.166	3/22/80	0.037	0.0332	4/3/80	0.055	0.055
4/21/80	0.118	0.157	3/28/80	0.054	0.0396	4/9/80	0.010	0.046
4/27/80	0.093	0.146	4/3/80	0.058	0.0418	4/15/80	0.092	0.062
5/10/80	0.072	0.109	4/9/80	0.014	0.0362	4/21/80	0.033	0.048
5/27/80	0.461	0.188	4/15/80	0.063	0.0452	4/27/80	0.057	0.049
6/2/80	0.699	0.289	4/21/80	0.036	0.045	5/3/80	0.075	0.053
6/8/80	0.521	0.369	4/27/80	0.102	0.0546	5/9/80	0.114	0.074
6/14/80	0.299	0.410	5/3/80	0.137	0.0704	5/15/80	0.062	0.068
6/20/80	0.520	0.500	5/9/80	0.024	0.0724	5/28/80	0.172	0.096
6/26/80	0.228	0.453	5/15/80	0.041	0.068	6/2/80	0.426	0.170
7/2/80	0.449	0.403	5/21/80	0.196	0.1	6/8/80	0.289	0.213
7/8/80	0.743	0.448	5/27/80	0.093	0.0982	6/14/80	0.105	0.211
7/14/80	0.253	0.439	6/3/80	0.044	0.0796	6/20/80	0.422	0.283
7/20/80	0.220	0.379	6/8/80	0.046	0.084	6/26/80	0.180	0.284
7/27/80	0.335	0.400	6/15/80	0.474	0.1706	7/2/80	0.315	0.262
8/1/80	0.402	0.391	6/21/80	0.233	0.178	7/8/80	0.176	0.240
8/7/80	0.266	0.295	6/26/80	0.239	0.2072	7/14/80	0.130	0.245
8/13/80	0.185	0.282	7/1/80	0.206	0.2396	7/20/80	0.093	0.179
8/19/80	0.114	0.260	7/8/80	0.134	0.2572	7/26/80	0.295	0.202
8/25/80	0.247	0.243	7/15/80	0.095	0.1814	8/1/80	0.205	0.180
8/31/80	0.232	0.209	7/20/80	0.216	0.178	8/7/80	0.075	0.160
9/6/80	0.299	0.215	7/29/80	0.118	0.1538	8/13/80	0.119	0.157

Table D-2. Continued

Spokane (53-063-0016)			Vancouver (53-011-0006)			Yakima (53-77-1006)		
Date	TSP	0^a	Date	TSP	0^a	Date	TSP	0^a
9/18/80	0.354	0.249	8/1/80	0.087	0.13	8/19/80	0.107	0.160
9/24/80	0.285	0.283	8/7/80	0.193	0.1418	8/25/80	0.104	0.122
9/30/80	0.224	0.279	8/13/80	0.105	0.1438	8/31/80	0.036	0.088
10/6/80	0.431	0.319	8/19/80	0.117	0.124	9/6/80	0.171	0.107
10/12/80	0.111	0.281	8/25/80	0.088	0.118	9/12/80	0.227	0.129
10/18/80	0.192	0.249	8/31/80	0.026	0.1058	9/18/80	0.058	0.119
10/24/80	0.213	0.234	9/6/80	0.069	0.081	9/24/80	0.091	0.117
10/30/80	0.371	0.264	9/12/80	0.053	0.0706	9/30/80	0.245	0.158
11/5/80	0.139	0.205	9/18/80	0.031	0.0534	10/6/80	0.196	0.163
11/11/80	0.098	0.203	9/24/80	0.06	0.0478	10/12/80	0.055	0.129
11/17/80	0.159	0.196	9/30/80	0.033	0.0492	10/18/80	0.066	0.131
11/23/80	0.087	0.171	10/6/80	0.084	0.0522	10/24/80	0.120	0.136
11/29/80	0.069	0.110	10/12/80	0.039	0.0494	10/30/80	0.160	0.119
12/5/80	0.057	0.094	10/18/80	0.123	0.0678	11/5/80	0.041	0.088
12/11/80	0.095	0.093	10/24/80	0.053	0.0664	11/11/80	0.035	0.084
12/23/80	0.050	0.072	10/30/80	0.058	0.0714	11/17/80	0.085	0.088
12/29/80	0.249	0.104	11/5/80	0.035	0.0616	11/23/80	0.052	0.075
1/4/81	0.079	0.106	11/11/80	0.057	0.0652	11/29/80	0.037	0.050
1/10/81	0.191	0.133	11/17/80	0.03	0.0466	12/5/80	0.029	0.048
1/16/81	0.296	0.173	11/23/80	0.034	0.0428	12/11/80	0.105	0.062
1/22/81	0.160	0.195	11/29/80	0.014	0.034	12/23/80	0.056	0.056
1/28/81	0.072	0.160	12/5/80	0.017	0.0304	12/30/80	0.056	0.057
2/3/81	0.205	0.185	12/11/80	0.096	0.0382	1/4/81	0.045	0.058
2/9/81	0.357	0.218	12/17/80	0.032	0.0386	1/16/81	0.076	0.068
2/15/81	0.024	0.164	12/23/80	0.065	0.0448	1/20/81	0.040	0.055
2/21/81	0.113	0.154	12/29/80	0.02	0.046	1/22/81	0.030	0.049
2/27/81	0.289	0.198	1/4/81	0.058	0.0542	1/28/81	0.014	0.041
3/5/81	0.184	0.193	1/10/81	0.036	0.0422	2/3/81	0.082	0.048
3/11/81	0.450	0.212	1/16/81	0.038	0.0434	2/9/81	0.094	0.052
3/17/81	0.112	0.230	1/22/81	0.044	0.0392	2/15/81	0.036	0.051
3/23/81	0.198	0.247	1/28/81	0.04	0.0432	2/21/81	0.043	0.054
3/29/81	0.098	0.208	2/3/81	0.062	0.044	2/27/81	0.037	0.058
4/4/81	0.080	0.188	2/9/81	0.043	0.0454	3/5/81	0.076	0.057
4/10/81	0.147	0.127	2/15/81	0.015	0.0408	3/11/81	0.091	0.057
4/16/81	0.252	0.155	2/21/81	0.065	0.045	3/17/81	0.084	0.066
4/22/81	0.053	0.126	2/27/81	0.046	0.0462	3/23/81	0.148	0.087
4/28/81	0.122	0.131	3/5/81	0.075	0.0488	3/29/81	0.116	0.103
5/4/81	0.122	0.139	3/11/81	0.077	0.0556	4/4/81	0.086	0.105
5/10/81	0.088	0.127	3/17/81	0.066	0.0658	4/10/81	0.115	0.110
5/16/81	0.069	0.091	3/23/81	0.028	0.0584	4/16/81	0.097	0.112
5/22/81	0.107	0.102	3/29/81	0.018	0.0528	4/22/81	0.146	0.112
5/28/81	0.298	0.137	4/4/81	0.035	0.0448	4/28/81	0.093	0.107
6/3/81	0.176	0.148	4/10/81	0.021	0.0336	5/4/81	0.138	0.118
6/9/81	0.072	0.144	4/16/81	0.038	0.028	5/10/81	0.092	0.113
6/15/81	0.105	0.152	4/22/81	0.031	0.0286	5/16/81	0.054	0.105
6/21/81	0.050	0.140	4/28/81	0.037	0.0324	5/22/81	0.050	0.085
6/27/81	0.194	0.119	5/4/81	0.031	0.0316	5/28/81	0.111	0.089
7/3/81	0.192	0.123	5/10/81	0.05	0.0374	6/3/81	0.112	0.084
7/9/81	0.167	0.142	5/16/81	0.035	0.0368	6/9/81	0.018	0.069
7/15/81	0.217	0.164	5/22/81	0.05	0.0406	6/15/81	0.053	0.069

Table D-2. Continued

Spokane (53-063-0016)			Vancouver (53-011-0006)			Yakima (53-77-1006)		
Date	TSP	0[a]	Date	TSP	0[a]	Date	TSP	0[a]
7/21/81	0.216	0.197	5/28/81	0.159	0.065	6/21/81	0.030	0.065
7/27/81	0.169	0.192	6/3/81	0.039	0.0666	6/27/81	0.083	0.059
8/2/81	0.173	0.188	6/9/81	0.019	0.0604	7/3/81	0.074	0.052
8/8/81	0.163	0.188	6/15/81	0.056	0.0646	7/9/81	0.059	0.060
8/14/81	0.456	0.235	6/21/81	0.025	0.0596	7/15/81	0.060	0.061
8/20/81	0.245	0.241	6/27/81	0.096	0.047	7/21/81	0.055	0.066
8/26/81	0.213	0.250	7/3/81	0.071	0.0534	7/27/81	0.084	0.066
9/1/81	0.276	0.271	7/9/81	0.068	0.0632	8/2/81	0.054	0.062
9/7/81	0.131	0.264	7/15/81	0.095	0.071	8/8/81	0.075	0.066
9/13/81	0.226	0.218	7/21/81	0.054	0.0768	8/14/81	0.085	0.071
9/19/81	0.846	0.338	7/27/81	0.096	0.0768	8/20/81	0.041	0.068
9/25/81	0.090	0.314	8/2/81	0.054	0.0734	8/26/81	0.099	0.071
10/1/81	0.204	0.299	8/8/81	0.124	0.0846	9/2/81	0.044	0.069
10/7/81	0.039	0.281	8/14/81	0.085	0.0826	9/7/81	0.077	0.069
10/13/81	0.367	0.309	8/20/81	0.07	0.0858	9/13/81	0.048	0.062
10/19/81	0.202	0.180	8/26/81	0.073	0.0812	9/19/81	0.045	0.063
10/25/81	0.156	0.194	9/1/81	0.036	0.0776	9/25/81	0.062	0.055
10/31/81	0.111	0.175	9/7/81	0.085	0.0698	10/1/81	0.076	0.062
11/12/81	0.083	0.184	9/13/81	0.072	0.0672	10/7/81	0.021	0.050
11/18/81	0.097	0.130	9/19/81	0.042	0.0616	10/13/81	0.050	0.051
11/24/81	0.199	0.129	9/25/81	0.035	0.054	10/19/81	0.084	0.059
11/30/81	0.102	0.118	10/1/81	0.044	0.0556	10/25/81	0.102	0.067
12/6/81	0.041	0.104	10/7/81	0.019	0.0424	10/31/81	0.033	0.058
12/12/81	0.188	0.125	10/13/81	0.028	0.0336	11/6/81	0.079	0.070
12/18/81	0.057	0.117	10/19/81	0.042	0.0336	11/13/81	0.031	0.066
12/30/81	0.041	0.086	10/25/81	0.109	0.0484	11/19/81	0.027	0.054
1/5/82	0.147	0.095	10/31/81	0.036	0.0468	11/24/81	0.016	0.037
1/29/82	0.029	0.092	11/6/81	0.064	0.0558	11/30/81	0.071	0.045
2/4/82	0.291	0.113	11/12/81	0.023	0.0548	12/6/81	0.027	0.034
2/10/82	0.278	0.157	11/18/81	0.034	0.0532	12/12/81	0.062	0.041
2/16/82	0.047	0.158	11/24/81	0.075	0.0464	12/18/81	0.026	0.040
2/22/82	0.101	0.149	11/30/81	0.024	0.044	12/24/81	0.065	0.050
2/28/82	0.081	0.160	12/6/81	0.018	0.0348	12/30/81	0.028	0.042
3/6/82	0.205	0.142	12/12/81	0.028	0.0358	1/5/82	0.045	0.045
3/12/82	0.115	0.110	12/18/81	0.023	0.0336	1/11/82	0.082	0.049
3/24/82	0.312	0.163	12/24/81	0.03	0.0246	1/17/82	0.027	0.049
3/30/82	0.084	0.159	12/30/81	0.066	0.033	1/23/82	0.021	0.041
4/5/82	0.121	0.167	1/5/82	0.064	0.0422	1/29/82	0.052	0.045
4/11/82	0.040	0.134	1/11/82	0.109	0.0584	2/4/82	0.108	0.058
4/17/82	0.083	0.128	1/17/82	0.025	0.0588	2/10/82	0.134	0.068
4/23/82	0.370	0.140	1/23/82	0.014	0.0556	2/16/82	0.019	0.067
4/29/82	0.116	0.146	1/29/82	0.051	0.0526	2/22/82	0.038	0.070
5/5/82	0.175	0.157	2/4/82	0.039	0.0476	2/28/82	0.019	0.064
5/11/82	0.161	0.181	2/10/82	0.071	0.04	3/6/82	0.050	0.052
5/17/82	0.066	0.178	2/16/82	0.019	0.0388	3/12/82	0.030	0.031
5/23/82	0.057	0.115	2/22/82	0.024	0.0408	3/18/82	0.060	0.039
5/29/82	0.097	0.111	2/28/82	0.044	0.0394	3/24/82	0.091	0.050
6/4/82	0.167	0.110	3/6/82	0.099	0.0514	3/30/82	0.034	0.053
6/10/82	0.182	0.114	3/12/82	0.036	0.0444	4/5/82	0.031	0.049
6/16/82	0.148	0.130	3/18/82	0.089	0.0584	4/11/82	0.012	0.046

Table D-2. Continued

Spokane (53-063-0016)			Vancouver (53-011-0006)			Yakima (53-77-1006)		
Date	**TSP**	0[a]	**Date**	**TSP**	0[a]	**Date**	**TSP**	0[a]
6/22/82	0.119	0.143	3/24/82	0.104	0.0744	4/17/82	0.105	0.055
6/28/82	0.081	0.139	3/30/82	0.018	0.0692	4/23/82	0.339	0.104
7/4/82	0.032	0.112	4/5/82	0.025	0.0544	4/29/82	0.099	0.117
7/10/82	0.081	0.092	4/11/82	0.023	0.0518	5/5/82	0.096	0.130
7/16/82	0.067	0.076	4/17/82	0.038	0.0416	5/11/82	0.054	0.139
7/22/82	0.121	0.076	4/23/82	0.083	0.0374	5/17/82	0.027	0.123
7/28/82	0.260	0.112	4/29/82	0.072	0.0482	5/23/82	0.036	0.062
8/3/82	0.133	0.132	5/5/82	0.075	0.0582	5/29/82	0.040	0.051
8/9/82	0.453	0.207	5/11/82	0.061	0.0658	6/4/82	0.169	0.065
8/15/82	0.091	0.212	5/17/82	0.026	0.0634	6/10/82	0.068	0.068
8/21/82	0.152	0.218	5/23/82	0.089	0.0646	6/16/82	0.052	0.073
8/27/82	0.286	0.223	5/29/82	0.084	0.067	6/22/82	0.062	0.078
9/2/82	0.213	0.239	6/4/82	0.034	0.0588	6/28/82	0.024	0.075
9/8/82	0.183	0.185	6/10/82	0.108	0.0682	7/4/82	0.016	0.044
9/14/82	0.166	0.200	6/16/82	0.068	0.0766	7/10/82	0.038	0.038
9/20/82	0.132	0.196	6/22/82	0.081	0.075	7/16/82	0.032	0.034
9/26/82	0.035	0.146	6/28/82	0.036	0.0654	7/22/82	0.039	0.030
10/2/82	0.048	0.113	7/4/82	0.032	0.065	8/3/82	0.038	0.033
10/8/82	0.149	0.106	7/10/82	0.05	0.0534	8/9/82	0.060	0.041
10/14/82	0.205	0.114	7/16/82	0.053	0.0504	8/15/82	0.029	0.040
10/20/82	0.267	0.141	7/22/82	0.089	0.052	8/21/82	0.059	0.045
10/26/82	0.030	0.140	7/28/82	0.063	0.0574	8/27/82	0.059	0.049
11/1/82	0.104	0.151	8/3/82	0.051	0.0612	9/2/82	0.066	0.055
11/7/82	0.067	0.135	8/9/82	0.037	0.0586	9/8/82	0.044	0.051
11/13/82	0.120	0.118	8/15/82	0.031	0.0542	9/20/82	0.021	0.050
11/19/82	0.029	0.070	8/21/82	0.08	0.0524	9/26/82	0.024	0.043
11/25/82	0.137	0.091	8/27/82	0.076	0.055	9/30/82	0.030	0.037
12/1/82	0.123	0.095	9/2/82	0.068	0.0584	10/2/82	0.036	0.031
12/7/82	0.178	0.117	9/8/82	0.05	0.061	10/8/82	0.045	0.031
12/13/82	0.039	0.101	9/14/82	0.061	0.067	10/14/82	0.083	0.044
12/19/82	0.082	0.112	9/20/82	0.023	0.0556	10/20/82	0.072	0.053
12/25/82	0.073	0.099	9/26/82	0.022	0.0448	10/26/82	0.011	0.049
12/31/82	0.110	0.096	10/2/82	0.044	0.04	11/1/82	0.028	0.048
			10/8/82	0.032	0.0364	11/7/82	0.030	0.045
			10/14/82	0.107	0.0456	11/13/82	0.052	0.039
			10/20/82	0.056	0.0522	11/19/82	0.031	0.030
			10/26/82	0.022	0.0522	11/25/82	0.043	0.037
			11/1/82	0.053	0.054	12/2/82	0.066	0.044
			11/7/82	0.024	0.0524	12/7/82	0.022	0.043
			11/13/82	0.063	0.0436	12/13/82	0.093	0.051
			11/19/82	0.025	0.0374	12/19/82	0.028	0.050
			11/25/82	0.064	0.0458	12/25/82	0.067	0.055
			12/1/82	0.029	0.041	12/31/82	0.014	0.045
			12/7/82	0.056	0.0474			
			12/13/82	0.046	0.044			
			12/19/82	0.03	0.045			
			12/25/82	0.036	0.0394			
			12/31/82	0.075	0.0486			

Notes: DTN: MO008SPATSP00.013

[a]Running average of the measurement for a day and the four previous measurements.

APPENDIX E. TSP:PM_{10} RATIOS – YUCCA MOUNTAIN

Table E-1 presents 1,276 measurements of PM_{10} and TSP concentrations (μg/m^3) taken simultaneously at three sites at Yucca Mountain during 1989 through 1997, and the TSP:PM_{10} ratio of those measurements. Measurements resulting in 24 ratios of ≤1.0 are not shown (see Section 6.1.3.1 for justification).

Table E-1. TSP:PM_{10} Ratios – Yucca Mountain, 1989–1997.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1	4/22/89	17	37	2.2	TM000000000001.082
1C	4/22/89	18	35	1.9	TM000000000001.082
1C	4/28/89	6	12	2.0	TM000000000001.082
1	5/4/89	8	12	1.5	TM000000000001.082
1C	5/4/89	10	11	1.1	TM000000000001.082
1	5/10/89	12	24	2.0	TM000000000001.082
5	5/10/89	15	34	2.3	TM000000000001.082
1C	5/10/89	12	23	1.9	TM000000000001.082
1	5/16/89	9	12	1.3	TM000000000001.082
5	5/16/89	10	18	1.8	TM000000000001.082
1C	5/16/89	7	11	1.6	TM000000000001.082
1	5/22/89	15	27	1.8	TM000000000001.082
5	5/22/89	16	32	2.0	TM000000000001.082
1	6/3/89	11	17	1.5	TM000000000001.082
5	6/3/89	11	23	2.1	TM000000000001.082
1C	6/3/89	13	16	1.2	TM000000000001.082
1	6/9/89	13	26	2.0	TM000000000001.082
5	6/9/89	18	62	3.4	TM000000000001.082
1C	6/9/89	12	23	1.9	TM000000000001.082
1	6/15/89	16	24	1.5	TM000000000001.082
5	6/15/89	17	30	1.8	TM000000000001.082
1C	6/15/89	15	24	1.6	TM000000000001.082
5	6/21/89	8	21	2.6	TM000000000001.082
1	6/27/89	13	25	1.9	TM000000000001.082
5	6/27/89	15	39	2.6	TM000000000001.082
1C	6/27/89	12	26	2.2	TM000000000001.082
1	7/3/89	10	15	1.5	TM000000000001.082
1	7/9/89	41	88	2.1	TM000000000001.082
5	7/9/89	38	90	2.4	TM000000000001.082
1C	7/9/89	38	86	2.3	TM000000000001.082
5	7/15/89	18	34	1.9	TM000000000001.082
1	7/21/89	26	52	2.0	TM000000000001.082
5	7/21/89	26	50	1.9	TM000000000001.082
1C	7/21/89	27	54	2.0	TM000000000001.082
1	7/27/89	27	50	1.9	TM000000000001.082
5	7/27/89	26	52	2.0	TM000000000001.082
1C	7/27/89	27	48	1.8	TM000000000001.082
1	8/8/89	23	42	1.8	TM000000000001.082
5	8/8/89	22	58	2.6	TM000000000001.082
1	8/14/89	13	22	1.7	TM000000000001.082
1	8/20/89	16	34	2.1	TM000000000001.082
5	8/20/89	13	27	2.1	TM000000000001.082
1	8/26/89	14	30	2.1	TM000000000001.082
5	8/26/89	14	23	1.6	TM000000000001.082
1C	8/26/89	19	34	1.8	TM000000000001.082
1	9/1/89	10	24	2.4	TM000000000001.082
1	9/7/89	17	41	2.4	TM000000000001.082
5	9/7/89	16	40	2.5	TM000000000001.082
1	9/13/89	9	17	1.9	TM000000000001.082
5	9/13/89	10	21	2.1	TM000000000001.082
1C	9/13/89	9	13	1.4	TM000000000001.082
1C	9/19/89	8	13	1.6	TM000000000001.082
1	9/25/89	9	20	2.2	TM000000000001.082
1C	9/25/89	9	15	1.7	TM000000000001.082
1	10/7/89	7	11	1.6	TM000000000001.082
1C	10/7/89	6	9	1.5	TM000000000001.082
5	10/13/89	11	22	2.0	TM000000000001.082
1	10/19/89	7	88	12.6	TM000000000001.082
1	10/25/89	4	19	4.8	TM000000000001.082
5	10/25/89	5	16	3.2	TM000000000001.082
5	10/31/89	5	11	2.2	TM000000000001.082
1	11/6/89	8	23	2.9	TM000000000001.082
5	11/6/89	9	17	1.9	TM000000000001.082
1	11/12/89	7	15	2.1	TM000000000001.082
5	11/12/89	8	14	1.8	TM000000000001.082
1	11/18/89	3	10	3.3	TM000000000001.082
5	11/18/89	5	9	1.8	TM000000000001.082
1	11/24/89	16	29	1.8	TM000000000001.082
1	11/30/89	2	8	4.0	TM000000000001.082
5	11/30/89	3	5	1.7	TM000000000001.082
1	12/6/89	3	9	3.0	TM000000000001.082
5	12/6/89	4	14	3.5	TM000000000001.082
1	12/12/89	5	9	1.8	TM000000000001.082
5	12/12/89	3	5	1.7	TM000000000001.082
1	12/18/89	4	12	3.0	TM000000000001.082
5	12/18/89	5	11	2.2	TM000000000001.082
1	12/24/89	2	4	2.0	TM000000000001.082
5	12/24/89	2	3	1.5	TM000000000001.082
1	12/30/89	2	8	4.0	TM000000000001.082
5	12/30/89	2	10	5.0	TM000000000001.082
1	1/5/90	2	4	2.0	TM000000000001.082
5	1/5/90	2	4	2.0	TM000000000001.082
1	1/11/90	4	7	1.8	TM000000000001.082
5	1/11/90	4	6	1.5	TM000000000001.082
1C	1/11/90	4	7	1.8	TM000000000001.082

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1	1/17/90	3	4	1.3	TM000000000001.082
1C	1/17/90	2	3	1.5	TM000000000001.082
1	1/23/90	3	6	2.0	TM000000000001.082
1C	1/23/90	3	5	1.7	TM000000000001.082
1	1/29/90	4	9	2.3	TM000000000001.082
1C	1/29/90	3	9	3.0	TM000000000001.082
1	2/4/90	5	10	2.0	TM000000000001.082
1C	2/4/90	5	10	2.0	TM000000000001.082
1	2/10/90	2	4	2.0	TM000000000001.082
1C	2/28/90	7	12	1.7	TM000000000001.082
1	3/6/90	2	5	2.5	TM000000000001.082
1C	3/6/90	2	4	2.0	TM000000000001.082
1	3/12/90	1	9	9.0	TM000000000001.082
1C	3/12/90	1	9	9.0	TM000000000001.082
1	3/18/90	4	6	1.5	TM000000000001.082
1C	3/18/90	4	5	1.3	TM000000000001.082
1	3/24/90	6	9	1.5	TM000000000001.082
1C	3/24/90	6	8	1.3	TM000000000001.082
1	3/30/90	6	11	1.8	TM000000000001.082
1C	3/30/90	6	11	1.8	TM000000000001.082
1	4/5/90	7	12	1.7	TM000000000001.082
1C	4/5/90	8	14	1.8	TM000000000001.082
1	4/11/90	7	8	1.1	TM000000000001.082
1C	4/11/90	7	8	1.1	TM000000000001.082
1	4/17/90	5	8	1.6	TM000000000001.082
1C	4/17/90	5	10	2.0	TM000000000001.082
1	4/23/90	25	56	2.2	TM000000000001.082
1	4/29/90	8	17	2.1	TM000000000001.082
1	5/11/90	24	40	1.7	TM000000000001.082
1	5/17/90	22	44	2.0	TM000000000001.082
1	5/23/90	31	64	2.1	TM000000000001.082
1	5/29/90	5	7	1.4	TM000000000001.082
1	6/4/90	12	19	1.6	TM000000000001.082
1	6/10/90	7	21	3.0	TM000000000001.082
1	6/16/90	8	30	3.8	TM000000000001.082
1	6/22/90	13	48	3.7	TM000000000001.082
1	6/28/90	10	38	3.8	TM000000000001.082
1	7/4/90	15	24	1.6	TM000000000001.082
1	7/10/90	12	21	1.8	TM000000000001.082
1	7/16/90	9	19	2.1	TM000000000001.082
1	7/28/90	14	29	2.1	TM000000000001.082
1	8/3/90	41	80	2.0	TM000000000001.082
1	8/21/90	15	26	1.7	TM000000000001.082
1	8/27/90	16	23	1.4	TM000000000001.082
1	9/8/90	14	23	1.6	TM000000000001.082
1	9/14/90	11	21	1.9	TM000000000001.082
1	9/20/90	9	18	2.0	TM000000000001.082
1	9/26/90	12	20	1.7	TM000000000001.082
1	10/8/90	9	14	1.6	TM000000000001.082
5	10/8/90	7	18	2.6	TM000000000001.082

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	10/8/90	8	13	1.6	TM000000000001.082
1	10/14/90	9	13	1.4	TM000000000001.082
5	10/14/90	8	12	1.5	TM000000000001.082
1C	10/14/90	8	11	1.4	TM000000000001.082
1	10/20/90	4	8	2.0	TM000000000001.082
5	10/20/90	5	9	1.8	TM000000000001.082
1C	10/20/90	4	6	1.5	TM000000000001.082
5	10/26/90	8	11	1.4	TM000000000001.082
1C	10/26/90	6	11	1.8	TM000000000001.082
1	11/1/90	6	18	3.0	TM000000000001.082
1	11/7/90	2	9	4.5	TM000000000001.082
5	11/7/90	6	13	2.2	TM000000000001.082
1C	11/7/90	3	8	2.7	TM000000000001.082
1	11/13/90	8	9	1.1	TM000000000001.082
5	11/13/90	5	8	1.6	TM000000000001.082
1C	11/13/90	6	8	1.3	TM000000000001.082
1	11/19/90	11	19	1.7	TM000000000001.082
5	11/19/90	12	18	1.5	TM000000000001.082
1C	11/19/90	11	17	1.5	TM000000000001.082
1	11/25/90	62	152	2.5	TM000000000001.082
1	12/1/90	4	11	2.8	TM000000000001.082
1C	12/1/90	3	13	4.3	TM000000000001.082
1	12/7/90	4	13	3.3	TM000000000001.082
5	12/7/90	4	7	1.8	TM000000000001.082
1C	12/7/90	5	13	2.6	TM000000000001.082
5	12/13/90	9	16	1.8	TM000000000001.082
1C	12/13/90	10	15	1.5	TM000000000001.082
1	12/19/90	49	145	3.0	TM000000000001.082
5	12/25/90	1	6	6.0	TM000000000001.082
1	12/31/90	1	7	7.0	TM000000000001.082
5	12/31/90	2	10	5.0	TM000000000001.082
1	1/6/91	1	4	4.0	TM000000000001.041
1	1/12/91	1	6	6.0	TM000000000001.041
5	1/12/91	4	11	2.8	TM000000000001.041
1	1/30/91	6	27	4.5	TM000000000001.041
5	1/30/91	3	24	8.0	TM000000000001.041
1C	1/30/91	6	27	4.5	TM000000000001.041
1	2/5/91	5	14	2.8	TM000000000001.041
5	2/11/91	6	11	1.8	TM000000000001.041
1	2/17/91	4	10	2.5	TM000000000001.041
5	2/17/91	5	14	2.8	TM000000000001.041
1C	2/17/91	4	9	2.3	TM000000000001.041
1	2/23/91	7	13	1.9	TM000000000001.041
5	2/23/91	5	14	2.8	TM000000000001.041
1C	2/23/91	7	10	1.4	TM000000000001.041
1	3/1/91	1	4	4.0	TM000000000001.041
5	3/1/91	2	4	2.0	TM000000000001.041
1C	3/1/91	1	4	4.0	TM000000000001.041
1	3/7/91	2	4	2.0	TM000000000001.041
5	3/7/91	3	5	1.7	TM000000000001.041

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	3/7/91	2	4	2.0	TM000000000001.041
1	3/13/91	6	14	2.3	TM000000000001.041
5	3/13/91	5	14	2.8	TM000000000001.041
1C	3/13/91	6	13	2.2	TM000000000001.041
1	3/19/91	4	14	3.5	TM000000000001.041
5	3/19/91	5	16	3.2	TM000000000001.041
1C	3/19/91	5	14	2.8	TM000000000001.041
1	3/25/91	9	21	2.3	TM000000000001.041
5	3/25/91	10	23	2.3	TM000000000001.041
1C	3/25/91	9	20	2.2	TM000000000001.041
1	3/31/91	7	13	1.9	TM000000000001.041
1C	3/31/91	7	12	1.7	TM000000000001.041
5	4/6/91	16	41	2.6	TM000000000001.041
1C	4/6/91	22	49	2.2	TM000000000001.041
1	4/12/91	6	12	2.0	TM000000000001.041
5	4/12/91	4	13	3.3	TM000000000001.041
1C	4/12/91	5	18	3.6	TM000000000001.041
1	4/18/91	6	10	1.7	TM000000000001.041
1C	4/18/91	5	9	1.8	TM000000000001.041
1	4/24/91	18	33	1.8	TM000000000001.041
5	4/24/91	20	33	1.7	TM000000000001.041
1C	4/24/91	19	33	1.7	TM000000000001.041
1	4/30/91	10	20	2.0	TM000000000001.041
5	4/30/91	10	19	1.9	TM000000000001.041
1C	4/30/91	10	19	1.9	TM000000000001.041
1	5/6/91	9	18	2.0	TM000000000001.041
5	5/6/91	10	14	1.4	TM000000000001.041
1C	5/6/91	9	16	1.8	TM000000000001.041
5	5/12/91	11	20	1.8	TM000000000001.041
1C	5/12/91	10	21	2.1	TM000000000001.041
1	5/18/91	8	21	2.6	TM000000000001.041
1C	5/18/91	9	21	2.3	TM000000000001.041
1	5/24/91	11	18	1.6	TM000000000001.041
5	5/24/91	11	17	1.5	TM000000000001.041
1C	5/24/91	11	18	1.6	TM000000000001.041
1	5/30/91	22	63	2.9	TM000000000001.041
5	5/30/91	33	103	3.1	TM000000000001.041
1	6/5/91	20	37	1.9	TM000000000001.041
5	6/5/91	22	41	1.9	TM000000000001.041
1C	6/5/91	17	37	2.2	TM000000000001.041
1	6/11/91	21	40	1.9	TM000000000001.041
1C	6/11/91	21	41	2.0	TM000000000001.041
1	6/17/91	12	28	2.3	TM000000000001.041
1C	6/17/91	11	23	2.1	TM000000000001.041
1	6/23/91	15	27	1.8	TM000000000001.041
1C	6/23/91	15	24	1.6	TM000000000001.041
5	6/29/91	11	26	2.4	TM000000000001.041
1	7/5/91	25	62	2.5	TM000000000001.042
5	7/5/91	26	54	2.1	TM000000000001.042
1C	7/5/91	27	59	2.2	TM000000000001.042
5	7/11/91	12	24	2.0	TM000000000001.042
1C	7/11/91	13	19	1.5	TM000000000001.042
1	7/17/91	10	15	1.5	TM000000000001.042
5	7/17/91	9	18	2.0	TM000000000001.042
1	7/23/91	9	17	1.9	TM000000000001.042
5	7/23/91	9	16	1.8	TM000000000001.042
1C	7/23/91	9	18	2.0	TM000000000001.042
1	7/29/91	14	35	2.5	TM000000000001.042
5	7/29/91	15	38	2.5	TM000000000001.042
1C	7/29/91	14	38	2.7	TM000000000001.042
1	8/4/91	10	20	2.0	TM000000000001.042
5	8/4/91	31	53	1.7	TM000000000001.042
1	8/10/91	33	61	1.8	TM000000000001.042
5	8/10/91	45	87	1.9	TM000000000001.042
1C	8/10/91	31	63	2.0	TM000000000001.042
1	8/16/91	15	24	1.6	TM000000000001.042
5	8/16/91	15	24	1.6	TM000000000001.042
1C	8/16/91	15	26	1.7	TM000000000001.042
5	8/22/91	10	20	2.0	TM000000000001.042
1C	8/22/91	16	29	1.8	TM000000000001.042
1	8/28/91	11	28	2.5	TM000000000001.042
5	8/28/91	11	28	2.5	TM000000000001.042
1C	8/28/91	14	26	1.9	TM000000000001.042
1	9/3/91	17	45	2.6	TM000000000001.042
5	9/3/91	16	45	2.8	TM000000000001.042
1C	9/3/91	17	44	2.6	TM000000000001.042
1	9/9/91	14	33	2.4	TM000000000001.042
5	9/9/91	17	41	2.4	TM000000000001.042
1	9/15/91	6	15	2.5	TM000000000001.042
5	9/15/91	6	16	2.7	TM000000000001.042
1C	9/15/91	6	20	3.3	TM000000000001.042
1	9/21/91	18	35	1.9	TM000000000001.042
5	9/21/91	17	33	1.9	TM000000000001.042
1C	9/21/91	17	48	2.8	TM000000000001.042
1	9/27/91	12	22	1.8	TM000000000001.042
1C	9/27/91	9	28	3.1	TM000000000001.042
1	1/1/92	3	7	2.3	TM000000000001.039
5	1/1/92	3	5	1.7	TM000000000001.039
1C	1/1/92	3	7	2.3	TM000000000001.039
1	1/7/92	3	5	1.7	TM000000000001.039
5	1/7/92	3	7	2.3	TM000000000001.039
1C	1/7/92	2	6	3.0	TM000000000001.039
1	1/13/92	2	7	3.5	TM000000000001.039
5	1/13/92	12	45	3.8	TM000000000001.039
1C	1/13/92	3	6	2.0	TM000000000001.039
1	1/19/92	3	6	2.0	TM000000000001.039
5	1/19/92	3	6	2.0	TM000000000001.039
1C	1/19/92	3	5	1.7	TM000000000001.039
5	1/25/92	5	14	2.8	TM000000000001.039
1C	1/25/92	4	8	2.0	TM000000000001.039

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1	1/31/92	5	10	2.0	TM000000000001.039
5	1/31/92	15	38	2.5	TM000000000001.039
1C	1/31/92	6	10	1.7	TM000000000001.039
1	2/6/92	5	11	2.2	TM000000000001.039
5	2/6/92	5	10	2.0	TM000000000001.039
1C	2/6/92	5	10	2.0	TM000000000001.039
1	2/12/92	2	5	2.5	TM000000000001.039
5	2/12/92	3	5	1.7	TM000000000001.039
1C	2/12/92	2	5	2.5	TM000000000001.039
1	2/19/92	4	9	2.3	TM000000000001.039
5	2/19/92	4	9	2.3	TM000000000001.039
1C	2/19/92	5	10	2.0	TM000000000001.039
1	2/24/92	3	8	2.7	TM000000000001.039
5	2/24/92	7	21	3.0	TM000000000001.039
1C	2/24/92	3	9	3.0	TM000000000001.039
5	3/1/92	7	16	2.3	TM000000000001.039
1	3/7/92	3	7	2.3	TM000000000001.039
5	3/7/92	3	6	2.0	TM000000000001.039
1C	3/7/92	2	7	3.5	TM000000000001.039
1	3/13/92	9	14	1.6	TM000000000001.039
5	3/13/92	10	20	2.0	TM000000000001.039
1C	3/13/92	8	15	1.9	TM000000000001.039
1	3/19/92	8	14	1.8	TM000000000001.039
5	3/19/92	11	22	2.0	TM000000000001.039
1C	3/19/92	8	15	1.9	TM000000000001.039
1	3/25/92	5	9	1.8	TM000000000001.039
5	3/25/92	5	13	2.6	TM000000000001.039
1C	3/25/92	5	8	1.6	TM000000000001.039
1	3/31/92	2	5	2.5	TM000000000001.039
5	3/31/92	3	6	2.0	TM000000000001.039
1C	3/31/92	3	6	2.0	TM000000000001.039
1	4/6/92	15	24	1.6	TM000000000001.039
5	4/6/92	18	31	1.7	TM000000000001.039
1C	4/6/92	15	25	1.7	TM000000000001.039
1	4/12/92	11	21	1.9	TM000000000001.039
5	4/12/92	13	24	1.8	TM000000000001.039
1C	4/12/92	11	23	2.1	TM000000000001.039
1	4/18/92	12	30	2.5	TM000000000001.039
5	4/18/92	14	39	2.8	TM000000000001.039
1C	4/18/92	12	30	2.5	TM000000000001.039
1	4/24/92	12	21	1.8	TM000000000001.039
5	4/24/92	14	25	1.8	TM000000000001.039
1C	4/24/92	12	22	1.8	TM000000000001.039
1	4/30/92	23	59	2.6	TM000000000001.039
5	4/30/92	49	130	2.7	TM000000000001.039
1C	4/30/92	23	61	2.7	TM000000000001.039
1	5/6/92	6	14	2.3	TM000000000001.039
1C	5/6/92	6	15	2.5	TM000000000001.039
1	5/12/92	15	27	1.8	TM000000000001.039
5	5/12/92	15	31	2.1	TM000000000001.039
1C	5/12/92	15	28	1.9	TM000000000001.039
1	5/18/92	13	24	1.8	TM000000000001.039
5	5/18/92	14	27	1.9	TM000000000001.039
1C	5/18/92	12	25	2.1	TM000000000001.039
1	5/24/92	10	18	1.8	TM000000000001.039
5	5/24/92	9	20	2.2	TM000000000001.039
1C	5/24/92	9	21	2.3	TM000000000001.039
1	5/30/92	13	26	2.0	TM000000000001.039
5	5/30/92	12	31	2.6	TM000000000001.039
1C	5/30/92	13	28	2.2	TM000000000001.039
1	6/5/92	24	59	2.5	TM000000000001.039
5	6/5/92	24	61	2.5	TM000000000001.039
1C	6/5/92	24	58	2.4	TM000000000001.039
1	6/11/92	23	42	1.8	TM000000000001.039
5	6/11/92	22	41	1.9	TM000000000001.039
1C	6/11/92	22	45	2.0	TM000000000001.039
1	6/17/92	10	23	2.3	TM000000000001.039
5	6/17/92	9	24	2.7	TM000000000001.039
1C	6/17/92	10	24	2.4	TM000000000001.039
1	6/23/92	18	37	2.1	TM000000000001.039
5	6/23/92	17	32	1.9	TM000000000001.039
1C	6/23/92	17	40	2.4	TM000000000001.039
1	6/29/92	21	67	3.2	TM000000000001.039
5	6/29/92	21	73	3.5	TM000000000001.039
1C	6/29/92	20	68	3.4	TM000000000001.039
1	7/5/92	12	32	2.7	TM000000000001.039
5	7/5/92	8	24	3.0	TM000000000001.039
1C	7/5/92	11	30	2.7	TM000000000001.039
1	7/11/92	21	50	2.4	TM000000000001.039
5	7/11/92	19	41	2.2	TM000000000001.039
1C	7/11/92	21	49	2.3	TM000000000001.039
1	7/17/92	16	39	2.4	TM000000000001.039
5	7/17/92	14	31	2.2	TM000000000001.039
1	7/23/92	18	43	2.4	TM000000000001.039
5	7/23/92	17	37	2.2	TM000000000001.039
1	7/29/92	16	36	2.3	TM000000000001.039
5	7/29/92	14	30	2.1	TM000000000001.039
1	8/4/92	30	73	2.4	TM000000000001.039
5	8/4/92	26	62	2.4	TM000000000001.039
1	8/10/92	14	35	2.5	TM000000000001.039
5	8/10/92	12	27	2.3	TM000000000001.039
1	8/16/92	19	41	2.2	TM000000000001.039
5	8/16/92	18	47	2.6	TM000000000001.039
1	8/22/92	19	55	2.9	TM000000000001.039
5	8/22/92	19	63	3.3	TM000000000001.039
1C	8/22/92	18	54	3.0	TM000000000001.039
1	8/28/92	17	39	2.3	TM000000000001.039
5	8/28/92	15	37	2.5	TM000000000001.039
1	9/3/92	20	53	2.7	TM000000000001.039
5	9/3/92	20	52	2.6	TM000000000001.039

Table E-1. Continued.

Site	Date	PM_{10} [a]	TSP [a]	Ratio [b]	DTN [c]
1C	9/3/92	21	53	2.5	TM000000000001.039
1	9/9/92	15	28	1.9	TM000000000001.039
5	9/9/92	13	25	1.9	TM000000000001.039
1	9/15/92	14	28	2.0	TM000000000001.039
1	9/21/92	14	28	2.0	TM000000000001.039
1	9/27/92	12	24	2.0	TM000000000001.039
5	9/27/92	11	24	2.2	TM000000000001.039
1	10/3/92	9	20	2.2	TM000000000001.079
5	10/3/92	8	25	3.1	TM000000000001.079
1C	10/3/92	7	22	3.1	TM000000000001.079
1	10/9/92	12	23	1.9	TM000000000001.079
5	10/9/92	11	20	1.8	TM000000000001.079
1C	10/9/92	12	24	2.0	TM000000000001.079
1	10/15/92	24	41	1.7	TM000000000001.079
5	10/15/92	27	48	1.8	TM000000000001.079
1C	10/15/92	24	42	1.8	TM000000000001.079
1	10/21/92	24	42	1.8	TM000000000001.079
5	10/21/92	19	31	1.6	TM000000000001.079
1C	10/21/92	23	43	1.9	TM000000000001.079
1	10/27/92	5	13	2.6	TM000000000001.079
5	10/27/92	5	10	2.0	TM000000000001.079
1C	10/27/92	5	13	2.6	TM000000000001.079
1	11/2/92	22	56	2.5	TM000000000001.079
5	11/2/92	15	51	3.4	TM000000000001.079
1C	11/2/92	16	54	3.4	TM000000000001.079
5	11/8/92	11	16	1.5	TM000000000001.079
1	11/14/92	1	3	3.0	TM000000000001.079
5	11/14/92	5	11	2.2	TM000000000001.079
1	11/20/92	21	45	2.1	TM000000000001.079
5	11/20/92	19	69	3.6	TM000000000001.079
1C	11/20/92	14	45	3.2	TM000000000001.079
1	12/2/92	15	35	2.3	TM000000000001.079
5	12/2/92	7	22	3.1	TM000000000001.079
1C	12/2/92	14	34	2.4	TM000000000001.079
1	12/8/92	11	13	1.2	TM000000000001.079
1C	12/8/92	9	12	1.3	TM000000000001.079
1	12/16/92	9	25	2.8	TM000000000001.079
1	12/26/92	4	15	3.8	TM000000000001.079
5	12/26/92	11	15	1.4	TM000000000001.079
1C	12/26/92	5	6	1.2	TM000000000001.079
5	1/7/93	9	11	1.2	TM000000000001.079
5	1/13/93	4	14	3.5	TM000000000001.079
1C	1/13/93	6	11	1.8	TM000000000001.079
1C	1/19/93	2	5	2.5	TM000000000001.079
5	1/25/93	1	5	5.0	TM000000000001.079
1C	1/25/93	10	29	2.9	TM000000000001.079
1	1/31/93	4	6	1.5	TM000000000001.079
5	1/31/93	4	6	1.5	TM000000000001.079
1C	1/31/93	3	5	1.7	TM000000000001.079
1	2/6/93	5	10	2.0	TM000000000001.079
1C	2/6/93	6	8	1.3	TM000000000001.079
5	2/12/93	2	6	3.0	TM000000000001.079
1	2/18/93	6	12	2.0	TM000000000001.079
5	2/18/93	5	10	2.0	TM000000000001.079
1C	2/18/93	5	11	2.2	TM000000000001.079
1	2/24/93	2	7	3.5	TM000000000001.079
5	2/24/93	2	9	4.5	TM000000000001.079
1C	2/24/93	2	11	5.5	TM000000000001.079
5	3/2/93	3	10	3.3	TM000000000001.079
1	3/3/93	3	11	3.7	TM000000000001.079
1C	3/3/93	4	10	2.5	TM000000000001.079
1	3/8/93	6	21	3.5	TM000000000001.079
5	3/8/93	4	11	2.8	TM000000000001.079
1C	3/8/93	7	19	2.7	TM000000000001.079
1	3/14/93	7	14	2.0	TM000000000001.079
5	3/14/93	6	14	2.3	TM000000000001.079
1C	3/14/93	6	13	2.2	TM000000000001.079
1	3/20/93	7	19	2.7	TM000000000001.079
5	3/20/93	6	14	2.3	TM000000000001.079
1C	3/20/93	7	17	2.4	TM000000000001.079
1	3/26/93	6	18	3.0	TM000000000001.079
5	3/26/93	6	53	8.8	TM000000000001.079
1C	3/26/93	7	15	2.1	TM000000000001.079
1	4/1/93	8	18	2.3	TM000000000001.079
5	4/1/93	7	17	2.4	TM000000000001.079
1C	4/1/93	7	19	2.7	TM000000000001.079
1	4/7/93	10	30	3.0	TM000000000001.079
5	4/7/93	5	12	2.4	TM000000000001.079
1C	4/7/93	11	30	2.7	TM000000000001.079
1	4/13/93	5	20	4.0	TM000000000001.079
5	4/13/93	4	13	3.3	TM000000000001.079
1C	4/13/93	5	19	3.8	TM000000000001.079
1	4/19/93	7	24	3.4	TM000000000001.079
5	4/19/93	7	24	3.4	TM000000000001.079
1C	4/19/93	8	24	3.0	TM000000000001.079
1	4/25/93	7	21	3.0	TM000000000001.079
5	4/25/93	7	22	3.1	TM000000000001.079
1C	4/25/93	7	18	2.6	TM000000000001.079
1	5/1/93	18	33	1.8	TM000000000001.079
5	5/1/93	19	33	1.7	TM000000000001.079
1C	5/1/93	18	34	1.9	TM000000000001.079
1	5/7/93	18	41	2.3	TM000000000001.079
5	5/7/93	13	28	2.2	TM000000000001.079
1C	5/7/93	18	39	2.2	TM000000000001.079
1	5/13/93	19	42	2.2	TM000000000001.079
5	5/13/93	20	49	2.5	TM000000000001.079
1C	5/13/93	19	42	2.2	TM000000000001.079
1	5/19/93	16	28	1.8	TM000000000001.079
5	5/19/93	15	27	1.8	TM000000000001.079
1C	5/19/93	16	28	1.8	TM000000000001.079

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1	5/25/93	13	33	2.5	TM000000000001.079
5	5/25/93	9	30	3.3	TM000000000001.079
1C	5/25/93	11	35	3.2	TM000000000001.079
1	5/31/93	15	39	2.6	TM000000000001.079
5	5/31/93	19	56	2.9	TM000000000001.079
1C	5/31/93	15	39	2.6	TM000000000001.079
1	6/6/93	4	14	3.5	TM000000000001.079
5	6/6/93	4	16	4.0	TM000000000001.079
1C	6/6/93	4	13	3.3	TM000000000001.079
1	6/12/93	15	31	2.1	TM000000000001.079
5	6/12/93	14	32	2.3	TM000000000001.079
1C	6/12/93	15	32	2.1	TM000000000001.079
1	6/18/93	8	18	2.3	TM000000000001.079
5	6/18/93	8	16	2.0	TM000000000001.079
5	6/24/93	8	21	2.6	TM000000000001.079
1C	6/24/93	9	27	3.0	TM000000000001.079
1	6/30/93	15	36	2.4	TM000000000001.079
5	6/30/93	12	28	2.3	TM000000000001.079
1C	6/30/93	14	35	2.5	TM000000000001.079
1	7/7/93	20	37	1.9	TM000000000001.079
5	7/7/93	19	36	1.9	TM000000000001.079
1C	7/7/93	20	38	1.9	TM000000000001.079
1	7/12/93	21	46	2.2	TM000000000001.079
5	7/12/93	21	46	2.2	TM000000000001.079
1C	7/12/93	21	44	2.1	TM000000000001.079
1	7/18/93	16	29	1.8	TM000000000001.079
5	7/18/93	16	31	1.9	TM000000000001.079
1C	7/18/93	13	30	2.3	TM000000000001.079
1	7/24/93	9	22	2.4	TM000000000001.079
5	7/24/93	8	25	3.1	TM000000000001.079
1C	7/24/93	9	22	2.4	TM000000000001.079
1	7/30/93	11	25	2.3	TM000000000001.079
5	7/30/93	9	21	2.3	TM000000000001.079
1C	7/30/93	12	25	2.1	TM000000000001.079
1	8/5/93	14	40	2.9	TM000000000001.079
5	8/5/93	11	28	2.5	TM000000000001.079
1C	8/5/93	14	39	2.8	TM000000000001.079
1	8/11/93	30	86	2.9	TM000000000001.079
5	8/11/93	12	32	2.7	TM000000000001.079
1C	8/11/93	32	82	2.6	TM000000000001.079
1	8/17/93	16	36	2.3	TM000000000001.079
5	8/17/93	10	16	1.6	TM000000000001.079
1C	8/17/93	16	35	2.2	TM000000000001.079
1	8/23/93	14	30	2.1	TM000000000001.079
5	8/23/93	12	25	2.1	TM000000000001.079
1C	8/23/93	14	29	2.1	TM000000000001.079
5	8/29/93	12	27	2.3	TM000000000001.079
1C	8/29/93	13	29	2.2	TM000000000001.079
1	9/4/93	9	25	2.8	TM000000000001.079
5	9/4/93	9	21	2.3	TM000000000001.079
1C	9/4/93	8	27	3.4	TM000000000001.079
5	9/10/93	8	20	2.5	TM000000000001.079
1C	9/10/93	11	28	2.5	TM000000000001.079
1	9/16/93	22	45	2.0	TM000000000001.079
5	9/16/93	20	45	2.3	TM000000000001.079
1C	9/16/93	20	46	2.3	TM000000000001.079
1	9/22/93	15	27	1.8	TM000000000001.079
5	9/22/93	14	26	1.9	TM000000000001.079
1C	9/22/93	15	27	1.8	TM000000000001.079
1	9/28/93	12	24	2.0	TM000000000001.079
5	9/28/93	10	20	2.0	TM000000000001.079
1C	9/28/93	11	24	2.2	TM000000000001.079
1	10/4/93	17	46	2.7	TM000000000001.079
5	10/4/93	20	54	2.7	TM000000000001.079
1C	10/4/93	18	43	2.4	TM000000000001.079
1	10/10/93	10	20	2.0	TM000000000001.079
5	10/10/93	8	16	2.0	TM000000000001.079
1C	10/10/93	9	19	2.1	TM000000000001.079
1	10/16/93	7	17	2.4	TM000000000001.079
5	10/16/93	6	15	2.5	TM000000000001.079
1C	10/16/93	6	17	2.8	TM000000000001.079
1	10/22/93	8	19	2.4	TM000000000001.079
5	10/22/93	6	15	2.5	TM000000000001.079
1C	10/22/93	8	19	2.4	TM000000000001.079
1	10/28/93	10	27	2.7	TM000000000001.079
5	10/28/93	6	13	2.2	TM000000000001.079
1C	10/28/93	10	28	2.8	TM000000000001.079
1	11/3/93	12	20	1.7	TM000000000001.079
5	11/3/93	8	15	1.9	TM000000000001.079
1C	11/3/93	13	19	1.5	TM000000000001.079
1	11/9/93	12	22	1.8	TM000000000001.079
5	11/9/93	10	18	1.8	TM000000000001.079
1C	11/9/93	12	22	1.8	TM000000000001.079
1	11/15/93	6	14	2.3	TM000000000001.079
5	11/15/93	5	10	2.0	TM000000000001.079
1C	11/15/93	6	14	2.3	TM000000000001.079
1	11/21/93	5	12	2.4	TM000000000001.079
5	11/21/93	6	14	2.3	TM000000000001.079
1	11/27/93	4	8	2.0	TM000000000001.079
5	11/27/93	1	6	6.0	TM000000000001.079
1C	11/27/93	4	7	1.8	TM000000000001.079
5	12/3/93	3	6	2.0	TM000000000001.079
1C	12/3/93	6	12	2.0	TM000000000001.079
1	12/9/93	10	33	3.3	TM000000000001.079
5	12/9/93	9	16	1.8	TM000000000001.079
1C	12/9/93	10	19	1.9	TM000000000001.079
1	12/15/93	2	8	4.0	TM000000000001.079
5	12/15/93	2	7	3.5	TM000000000001.079
1C	12/15/93	2	7	3.5	TM000000000001.079
1	12/21/93	3	9	3.0	TM000000000001.079

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
5	12/21/93	2	6	3.0	TM000000000001.079
1C	12/21/93	3	6	2.0	TM000000000001.079
1	12/27/93	5	11	2.2	TM000000000001.079
1C	12/27/93	4	9	2.3	TM000000000001.079
1	1/2/94	3	9	3.0	TM000000000001.079
5	1/2/94	3	11	3.7	TM000000000001.079
1C	1/2/94	2	8	4.0	TM000000000001.079
1	1/8/94	2	8	4.0	TM000000000001.079
5	1/8/94	2	5	2.5	TM000000000001.079
1	1/14/94	5	16	3.2	TM000000000001.079
5	1/14/94	1	7	7.0	TM000000000001.079
1C	1/14/94	5	15	3.0	TM000000000001.079
1	1/20/94	5	13	2.6	TM000000000001.079
5	1/20/94	3	9	3.0	TM000000000001.079
1C	1/20/94	5	10	2.0	TM000000000001.079
1	1/26/94	3	12	4.0	TM000000000001.079
5	1/26/94	1	5	5.0	TM000000000001.079
1C	1/26/94	2	12	6.0	TM000000000001.079
1	2/1/94	4	18	4.5	TM000000000001.079
5	2/1/94	1	4	4.0	TM000000000001.079
1C	2/1/94	5	16	3.2	TM000000000001.079
1	2/7/94	4	8	2.0	TM000000000001.079
5	2/7/94	5	7	1.4	TM000000000001.079
1C	2/7/94	3	8	2.7	TM000000000001.079
5	2/13/94	2	6	3.0	TM000000000001.079
1	2/15/94	10	21	2.1	TM000000000001.079
1C	2/15/94	10	21	2.1	TM000000000001.079
1	2/19/94	1	7	7.0	TM000000000001.079
5	2/19/94	2	6	3.0	TM000000000001.079
1C	2/19/94	3	8	2.7	TM000000000001.079
1	2/25/94	3	13	4.3	TM000000000001.079
5	2/25/94	3	7	2.3	TM000000000001.079
1C	2/25/94	3	11	3.7	TM000000000001.079
1	3/3/94	6	11	1.8	TM000000000001.079
5	3/3/94	5	9	1.8	TM000000000001.079
1C	3/3/94	5	12	2.4	TM000000000001.079
1C	3/9/94	5	12	2.4	TM000000000001.079
1	3/15/94	7	17	2.4	TM000000000001.079
5	3/15/94	9	18	2.0	TM000000000001.079
1C	3/15/94	6	19	3.2	TM000000000001.079
1	3/21/94	7	14	2.0	TM000000000001.079
5	3/21/94	9	18	2.0	TM000000000001.079
1C	3/21/94	9	16	1.8	TM000000000001.079
5	3/27/94	4	9	2.3	TM000000000001.079
1	4/2/94	2	14	7.0	TM000000000001.079
5	4/2/94	2	11	5.5	TM000000000001.079
1C	4/2/94	2	12	6.0	TM000000000001.079
1	4/8/94	11	26	2.4	TM000000000001.079
5	4/8/94	8	25	3.1	TM000000000001.079
1C	4/8/94	9	26	2.9	TM000000000001.079
1	4/14/94	24	44	1.8	TM000000000001.079
5	4/14/94	21	35	1.7	TM000000000001.079
1C	4/14/94	24	42	1.8	TM000000000001.079
1	4/20/94	13	30	2.3	TM000000000001.079
5	4/20/94	14	30	2.1	TM000000000001.079
1C	4/20/94	15	29	1.9	TM000000000001.079
1	4/26/94	5	20	4.0	TM000000000001.079
5	4/26/94	2	20	10.0	TM000000000001.079
1C	4/26/94	4	19	4.8	TM000000000001.079
1	5/2/94	12	19	1.6	TM000000000001.079
5	5/2/94	13	21	1.6	TM000000000001.079
1C	5/2/94	13	18	1.4	TM000000000001.079
1	5/8/94	3	9	3.0	TM000000000001.079
5	5/8/94	2	13	6.5	TM000000000001.079
1C	5/8/94	2	9	4.5	TM000000000001.079
1	5/14/94	16	25	1.6	TM000000000001.079
5	5/14/94	15	26	1.7	TM000000000001.079
1C	5/14/94	16	24	1.5	TM000000000001.079
1	5/20/94	2	13	6.5	TM000000000001.079
5	5/20/94	2	10	5.0	TM000000000001.079
1C	5/20/94	3	10	3.3	TM000000000001.079
1	5/26/94	11	26	2.4	TM000000000001.079
5	5/26/94	11	23	2.1	TM000000000001.079
1C	5/26/94	11	27	2.5	TM000000000001.079
1	6/1/94	12	20	1.7	TM000000000001.079
5	6/1/94	9	15	1.7	TM000000000001.079
1C	6/1/94	12	19	1.6	TM000000000001.079
1	6/7/94	8	22	2.8	TM000000000001.079
5	6/7/94	10	24	2.4	TM000000000001.079
1C	6/7/94	9	22	2.4	TM000000000001.079
5	6/13/94	14	31	2.2	TM000000000001.079
1C	6/13/94	13	29	2.2	TM000000000001.079
1	6/19/94	13	21	1.6	TM000000000001.079
5	6/19/94	11	19	1.7	TM000000000001.079
1C	6/19/94	12	21	1.8	TM000000000001.079
1	6/25/94	15	24	1.6	TM000000000001.079
5	6/25/94	13	22	1.7	TM000000000001.079
1C	6/25/94	14	22	1.6	TM000000000001.079
1	7/1/94	26	43	1.7	TM000000000001.079
5	7/1/94	23	41	1.8	TM000000000001.079
1C	7/1/94	26	43	1.7	TM000000000001.079
1	7/7/94	10	20	2.0	TM000000000001.079
5	7/7/94	5	14	2.8	TM000000000001.079
1C	7/7/94	10	22	2.2	TM000000000001.079
1	7/13/94	14	24	1.7	TM000000000001.079
5	7/13/94	11	20	1.8	TM000000000001.079
1C	7/13/94	12	23	1.9	TM000000000001.079
1	7/19/94	39	99	2.5	TM000000000001.079
5	7/19/94	42	98	2.3	TM000000000001.079
1C	7/19/94	40	102	2.6	TM000000000001.079

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1	7/25/94	19	32	1.7	TM000000000001.079
5	7/25/94	9	20	2.2	TM000000000001.079
1C	7/25/94	19	38	2.0	TM000000000001.079
1	7/29/94	26	50	1.9	TM000000000001.079
1C	7/29/94	25	51	2.0	TM000000000001.079
5	7/31/94	12	24	2.0	TM000000000001.079
1	8/6/94	16	28	1.8	TM000000000001.079
5	8/6/94	11	19	1.7	TM000000000001.079
1C	8/6/94	16	28	1.8	TM000000000001.079
1	8/12/94	15	31	2.1	TM000000000001.079
5	8/12/94	14	27	1.9	TM000000000001.079
1C	8/12/94	15	31	2.1	TM000000000001.079
1	8/18/94	17	28	1.6	TM000000000001.079
5	8/18/94	17	32	1.9	TM000000000001.079
1C	8/18/94	16	29	1.8	TM000000000001.079
5	8/24/94	12	25	2.1	TM000000000001.079
1C	8/24/94	11	24	2.2	TM000000000001.079
1	8/30/94	14	31	2.2	TM000000000001.079
5	8/30/94	10	17	1.7	TM000000000001.079
1	9/5/94	14	25	1.8	TM000000000001.079
5	9/5/94	13	22	1.7	TM000000000001.079
1C	9/5/94	14	27	1.9	TM000000000001.079
1	9/11/94	13	26	2.0	TM000000000001.079
5	9/11/94	14	31	2.2	TM000000000001.079
1C	9/11/94	14	27	1.9	TM000000000001.079
1C	9/17/94	11	25	2.3	TM000000000001.079
1	9/23/94	20	36	1.8	TM000000000001.079
5	9/23/94	11	18	1.6	TM000000000001.079
1C	9/23/94	20	37	1.9	TM000000000001.079
1	9/29/94	6	17	2.8	TM000000000001.079
1C	9/29/94	5	17	3.4	TM000000000001.079
1	10/5/94	8	13	1.6	TM000000000001.079
5	10/5/94	2	9	4.5	TM000000000001.079
1C	10/5/94	6	14	2.3	TM000000000001.079
1	10/11/94	12	24	2.0	TM000000000001.079
5	10/11/94	10	23	2.3	TM000000000001.079
1C	10/11/94	12	25	2.1	TM000000000001.079
1	10/17/94	2	15	7.5	TM000000000001.079
5	10/17/94	2	8	4.0	TM000000000001.079
1C	10/17/94	3	17	5.7	TM000000000001.079
1	10/23/94	7	16	2.3	TM000000000001.079
5	10/23/94	10	18	1.8	TM000000000001.079
1C	10/23/94	10	17	1.7	TM000000000001.079
1	10/29/94	6	14	2.3	TM000000000001.079
5	10/29/94	4	11	2.8	TM000000000001.079
1C	10/29/94	6	13	2.2	TM000000000001.079
1	11/4/94	8	21	2.6	TM000000000001.079
5	11/4/94	7	16	2.3	TM000000000001.079
1	11/10/94	8	15	1.9	TM000000000001.079
5	11/10/94	7	18	2.6	TM000000000001.079

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	11/10/94	3	16	5.3	TM000000000001.079
1	11/16/94	7	20	2.9	TM000000000001.079
5	11/16/94	11	41	3.7	TM000000000001.079
1C	11/16/94	6	20	3.3	TM000000000001.079
1	11/22/94	5	21	4.2	TM000000000001.079
5	11/22/94	3	9	3.0	TM000000000001.079
5	11/28/94	4	18	4.5	TM000000000001.079
1	11/29/94	6	16	2.7	TM000000000001.079
1C	11/29/94	6	20	3.3	TM000000000001.079
1	12/4/94	6	12	2.0	TM000000000001.079
5	12/4/94	7	17	2.4	TM000000000001.079
1C	12/4/94	7	14	2.0	TM000000000001.079
1	12/10/94	9	15	1.7	TM000000000001.079
5	12/10/94	3	10	3.3	TM000000000001.079
1C	12/10/94	6	18	3.0	TM000000000001.079
1	12/16/94	6	16	2.7	TM000000000001.079
5	12/16/94	5	18	3.6	TM000000000001.079
1C	12/16/94	6	11	1.8	TM000000000001.079
1	12/22/94	8	21	2.6	TM000000000001.079
5	12/22/94	17	35	2.1	TM000000000001.079
1C	12/22/94	9	12	1.3	TM000000000001.079
1	12/28/94	8	10	1.3	TM000000000001.079
5	12/28/94	6	12	2.0	TM000000000001.079
1	1/3/95	4	8	2.0	TM000000000001.079
5	1/3/95	4	7	1.8	TM000000000001.079
1C	1/3/95	4	8	2.0	TM000000000001.079
5	1/9/95	2	4	2.0	TM000000000001.079
1	1/15/95	2	3	1.5	TM000000000001.079
5	1/15/95	1	4	4.0	TM000000000001.079
1C	1/15/95	1	5	5.0	TM000000000001.079
1	1/21/95	7	10	1.4	TM000000000001.079
5	1/21/95	7	12	1.7	TM000000000001.079
1C	1/21/95	7	12	1.7	TM000000000001.079
1	1/27/95	3	7	2.3	TM000000000001.079
5	1/27/95	2	6	3.0	TM000000000001.079
1C	1/27/95	2	4	2.0	TM000000000001.079
1	2/2/95	6	18	3.0	TM000000000001.079
5	2/2/95	5	16	3.2	TM000000000001.079
1C	2/2/95	7	21	3.0	TM000000000001.079
1	2/8/95	7	16	2.3	TM000000000001.079
5	2/8/95	6	15	2.5	TM000000000001.079
1C	2/8/95	6	14	2.3	TM000000000001.079
1	2/14/95	5	13	2.6	TM000000000001.079
5	2/14/95	3	13	4.3	TM000000000001.079
1C	2/14/95	4	14	3.5	TM000000000001.079
1	2/20/95	3	9	3.0	TM000000000001.079
5	2/20/95	4	9	2.3	TM000000000001.079
1C	2/20/95	4	11	2.8	TM000000000001.079
1	2/26/95	7	12	1.7	TM000000000001.079
5	2/26/95	9	16	1.8	TM000000000001.079

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	2/26/95	8	13	1.6	TM000000000001.079
1	3/4/95	4	11	2.8	TM000000000001.079
5	3/4/95	3	13	4.3	TM000000000001.079
1C	3/4/95	4	7	1.8	TM000000000001.079
1	3/10/95	8	14	1.8	TM000000000001.079
5	3/10/95	7	17	2.4	TM000000000001.079
1C	3/10/95	7	15	2.1	TM000000000001.079
1	3/16/95	10	19	1.9	TM000000000001.079
5	3/16/95	8	16	2.0	TM000000000001.079
1C	3/16/95	10	21	2.1	TM000000000001.079
1	3/22/95	5	12	2.4	TM000000000001.079
5	3/22/95	5	16	3.2	TM000000000001.079
1C	3/22/95	5	13	2.6	TM000000000001.079
1	3/28/95	7	17	2.4	TM000000000001.079
5	3/28/95	8	18	2.3	TM000000000001.079
1C	3/28/95	7	18	2.6	TM000000000001.079
1	4/3/95	9	30	3.3	TM000000000001.079
5	4/3/95	12	37	3.1	TM000000000001.079
1C	4/3/95	10	30	3.0	TM000000000001.079
1	4/9/95	13	56	4.3	TM000000000001.079
5	4/9/95	67	310	4.6	TM000000000001.079
1C	4/9/95	9	51	5.7	TM000000000001.079
1	4/15/95	4	21	5.3	TM000000000001.079
5	4/15/95	9	32	3.6	TM000000000001.079
1C	4/15/95	9	20	2.2	TM000000000001.079
1	4/21/95	14	39	2.8	TM000000000001.079
5	4/21/95	11	69	6.3	TM000000000001.079
1C	4/21/95	10	25	2.5	TM000000000001.079
1	4/27/95	15	35	2.3	TM000000000001.079
5	4/27/95	12	36	3.0	TM000000000001.079
1C	4/27/95	12	37	3.1	TM000000000001.079
1	5/3/95	7	18	2.6	TM000000000001.079
5	5/3/95	20	41	2.1	TM000000000001.079
1C	5/3/95	8	18	2.3	TM000000000001.079
1	5/9/95	11	24	2.2	TM000000000001.079
5	5/9/95	11	24	2.2	TM000000000001.079
1C	5/9/95	12	25	2.1	TM000000000001.079
1	5/15/95	7	19	2.7	TM000000000001.079
5	5/15/95	3	12	4.0	TM000000000001.079
1C	5/15/95	3	18	6.0	TM000000000001.079
1	5/21/95	15	25	1.7	TM000000000001.079
5	5/21/95	16	28	1.8	TM000000000001.079
1C	5/21/95	15	27	1.8	TM000000000001.079
1	5/27/95	9	21	2.3	TM000000000001.079
5	5/27/95	8	15	1.9	TM000000000001.079
1C	5/27/95	9	22	2.4	TM000000000001.079
1	6/2/95	10	43	4.3	TM000000000001.079
5	6/2/95	10	31	3.1	TM000000000001.079
1C	6/2/95	10	41	4.1	TM000000000001.079
1	6/8/95	10	34	3.4	TM000000000001.079

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
5	6/8/95	6	26	4.3	TM000000000001.079
1C	6/8/95	9	33	3.7	TM000000000001.079
1	6/14/95	14	35	2.5	TM000000000001.079
5	6/14/95	17	50	2.9	TM000000000001.079
1C	6/14/95	15	34	2.3	TM000000000001.079
1	6/20/95	9	26	2.9	TM000000000001.079
5	6/20/95	11	37	3.4	TM000000000001.079
1C	6/20/95	9	26	2.9	TM000000000001.079
1	6/26/95	11	30	2.7	TM000000000001.079
5	6/26/95	11	36	3.3	TM000000000001.079
1C	6/26/95	11	31	2.8	TM000000000001.079
1	7/2/95	12	21	1.8	TM000000000001.079
5	7/2/95	8	19	2.4	TM000000000001.079
1	7/8/95	14	31	2.2	TM000000000001.079
5	7/8/95	15	36	2.4	TM000000000001.079
1C	7/8/95	14	33	2.4	TM000000000001.079
1	7/14/95	14	30	2.1	TM000000000001.079
5	7/14/95	12	30	2.5	TM000000000001.079
1C	7/14/95	13	43	3.3	TM000000000001.079
1	7/20/95	14	20	1.4	TM000000000001.079
5	7/20/95	14	25	1.8	TM000000000001.079
1C	7/20/95	9	26	2.9	TM000000000001.079
1	7/26/95	13	27	2.1	TM000000000001.079
5	7/26/95	12	27	2.3	TM000000000001.079
1C	7/26/95	12	34	2.8	TM000000000001.079
1	8/1/95	20	46	2.3	TM000000000001.079
5	8/1/95	18	38	2.1	TM000000000001.079
1C	8/1/95	19	45	2.4	TM000000000001.079
1	8/7/95	15	41	2.7	TM000000000001.079
5	8/7/95	16	36	2.3	TM000000000001.079
1C	8/7/95	15	43	2.9	TM000000000001.079
1	8/13/95	17	36	2.1	TM000000000001.079
5	8/13/95	14	28	2.0	TM000000000001.079
1C	8/13/95	16	36	2.3	TM000000000001.079
1	8/19/95	14	28	2.0	TM000000000001.079
5	8/19/95	14	18	1.3	TM000000000001.079
1	8/25/95	9	26	2.9	TM000000000001.079
5	8/25/95	10	21	2.1	TM000000000001.079
1C	8/25/95	9	19	2.1	TM000000000001.079
1	8/31/95	12	23	1.9	TM000000000001.079
5	8/31/95	12	23	1.9	TM000000000001.079
1C	8/31/95	13	26	2.0	TM000000000001.079
1	9/6/95	13	27	2.1	TM000000000001.079
5	9/6/95	14	30	2.1	TM000000000001.079
1	9/12/95	9	22	2.4	TM000000000001.079
1C	9/12/95	10	26	2.6	TM000000000001.079
1	9/18/95	21	53	2.5	TM000000000001.079
5	9/18/95	18	35	1.9	TM000000000001.079
1C	9/18/95	21	50	2.4	TM000000000001.079
1	9/24/95	16	25	1.6	TM000000000001.079

Table E-1. Continued.

Site	Date	PM_{10} [a]	TSP [a]	Ratio [b]	DTN [c]
5	9/24/95	11	23	2.1	TM000000000001.079
1C	9/24/95	12	24	2.0	TM000000000001.079
1	9/30/95	5	14	2.8	TM000000000001.079
5	9/30/95	5	15	3.0	TM000000000001.079
1C	9/30/95	5	14	2.8	TM000000000001.079
1	10/6/95	9	18	2.0	TM000000000001.079
5	10/6/95	13	23	1.8	TM000000000001.079
1C	10/6/95	9	20	2.2	TM000000000001.079
1	10/12/95	13	33	2.5	TM000000000001.079
1C	10/12/95	14	34	2.4	TM000000000001.079
1	10/18/95	16	31	1.9	TM000000000001.079
5	10/18/95	11	23	2.1	TM000000000001.079
1C	10/18/95	14	31	2.2	TM000000000001.079
1	10/24/95	7	18	2.6	TM000000000001.079
5	10/24/95	8	13	1.6	TM000000000001.079
1C	10/24/95	8	19	2.4	TM000000000001.079
1	10/30/95	7	15	2.1	TM000000000001.079
5	10/30/95	6	12	2.0	TM000000000001.079
1C	10/30/95	6	16	2.7	TM000000000001.079
1	11/5/95	5	10	2.0	TM000000000001.079
5	11/5/95	5	11	2.2	TM000000000001.079
1C	11/5/95	5	13	2.6	TM000000000001.079
1	11/11/95	3	13	4.3	TM000000000001.079
5	11/11/95	4	8	2.0	TM000000000001.079
1C	11/11/95	4	11	2.8	TM000000000001.079
1	11/17/95	16	34	2.1	TM000000000001.079
5	11/17/95	8	16	2.0	TM000000000001.079
1C	11/17/95	14	35	2.5	TM000000000001.079
1	11/23/95	7	18	2.6	TM000000000001.079
5	11/23/95	6	24	4.0	TM000000000001.079
1C	11/23/95	7	27	3.9	TM000000000001.079
5	11/29/95	5	12	2.4	TM000000000001.079
1	12/5/95	14	25	1.8	TM000000000001.079
5	12/5/95	9	14	1.6	TM000000000001.079
1C	12/5/95	13	26	2.0	TM000000000001.079
1	12/11/95	9	22	2.4	TM000000000001.079
1C	12/11/95	9	14	1.6	TM000000000001.079
1	12/17/95	2	4	2.0	TM000000000001.079
1C	12/17/95	1	4	4.0	TM000000000001.079
1	12/23/95	6	11	1.8	TM000000000001.079
5	12/23/95	6	12	2.0	TM000000000001.079
1C	12/23/95	6	10	1.7	TM000000000001.079
1	12/29/95	3	13	4.3	TM000000000001.079
5	12/29/95	4	14	3.5	TM000000000001.079
1C	12/29/95	4	9	2.3	TM000000000001.079
1	1/4/96	4	9	2.3	TM000000000001.084
5	1/4/96	6	12	2.0	TM000000000001.084
1C	1/4/96	5	10	2.0	TM000000000001.084
1	1/10/96	5	13	2.6	TM000000000001.084
5	1/10/96	4	9	2.3	TM000000000001.084

Site	Date	PM_{10} [a]	TSP [a]	Ratio [b]	DTN [c]
1C	1/10/96	5	13	2.6	TM000000000001.084
1	1/16/96	10	28	2.8	TM000000000001.084
5	1/16/96	7	25	3.6	TM000000000001.084
1C	1/16/96	10	28	2.8	TM000000000001.084
1	1/22/96	3	8	2.7	TM000000000001.084
5	1/22/96	2	5	2.5	TM000000000001.084
1C	1/22/96	2	8	4.0	TM000000000001.084
1	1/28/96	5	17	3.4	TM000000000001.084
5	1/28/96	5	16	3.2	TM000000000001.084
1C	1/28/96	5	17	3.4	TM000000000001.084
1	2/3/96	5	11	2.2	TM000000000001.084
5	2/3/96	4	8	2.0	TM000000000001.084
1C	2/3/96	5	11	2.2	TM000000000001.084
1	2/9/96	7	14	2.0	TM000000000001.084
5	2/9/96	7	13	1.9	TM000000000001.084
1C	2/9/96	7	14	2.0	TM000000000001.084
1	2/15/96	6	15	2.5	TM000000000001.084
5	2/15/96	8	17	2.1	TM000000000001.084
1C	2/15/96	7	14	2.0	TM000000000001.084
1	2/21/96	3	8	2.7	TM000000000001.084
1C	2/21/96	4	7	1.8	TM000000000001.084
1	2/27/96	3	8	2.7	TM000000000001.084
5	2/27/96	3	5	1.7	TM000000000001.084
1C	2/27/96	3	7	2.3	TM000000000001.084
1	3/4/96	8	28	3.5	TM000000000001.084
5	3/4/96	9	35	3.9	TM000000000001.084
1C	3/4/96	10	26	2.6	TM000000000001.084
1	3/10/96	5	12	2.4	TM000000000001.084
5	3/10/96	6	13	2.2	TM000000000001.084
1C	3/10/96	6	12	2.0	TM000000000001.084
1	3/16/96	6	12	2.0	TM000000000001.084
5	3/16/96	5	17	3.4	TM000000000001.084
1C	3/16/96	6	12	2.0	TM000000000001.084
1	3/22/96	22	51	2.3	TM000000000001.084
5	3/22/96	27	65	2.4	TM000000000001.084
1C	3/22/96	21	48	2.3	TM000000000001.084
1	3/28/96	23	77	3.3	TM000000000001.084
5	3/28/96	35	126	3.6	TM000000000001.084
1C	3/28/96	22	72	3.3	TM000000000001.084
1	4/3/96	5	11	2.2	TM000000000001.096
5	4/3/96	4	11	2.8	TM000000000001.096
1C	4/3/96	5	8	1.6	TM000000000001.096
1	4/9/96	9	21	2.3	TM000000000001.096
5	4/9/96	11	28	2.5	TM000000000001.096
1C	4/9/96	10	21	2.1	TM000000000001.096
1	4/15/96	7	20	2.9	TM000000000001.096
5	4/15/96	7	34	4.9	TM000000000001.096
1C	4/15/96	8	18	2.3	TM000000000001.096
1	4/21/96	5	11	2.2	TM000000000001.096
5	4/21/96	5	16	3.2	TM000000000001.096

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	4/21/96	5	10	2.0	TM000000000001.096
1	4/27/96	13	30	2.3	TM000000000001.096
5	4/27/96	15	38	2.5	TM000000000001.096
1C	4/27/96	14	27	1.9	TM000000000001.096
1	5/3/96	7	13	1.9	TM000000000001.096
5	5/3/96	8	26	3.3	TM000000000001.096
1C	5/3/96	7	12	1.7	TM000000000001.096
1	5/9/96	9	19	2.1	TM000000000001.096
5	5/9/96	10	23	2.3	TM000000000001.096
1C	5/9/96	10	19	1.9	TM000000000001.096
1	5/15/96	20	55	2.8	TM000000000001.096
1C	5/15/96	22	52	2.4	TM000000000001.096
1	5/21/96	15	25	1.7	TM000000000001.096
5	5/21/96	15	32	2.1	TM000000000001.096
1C	5/21/96	15	24	1.6	TM000000000001.096
1	5/27/96	12	25	2.1	TM000000000001.096
5	5/27/96	14	36	2.6	TM000000000001.096
1C	5/27/96	12	25	2.1	TM000000000001.096
1	6/2/96	11	17	1.5	TM000000000001.096
5	6/2/96	11	17	1.5	TM000000000001.096
1C	6/2/96	11	15	1.4	TM000000000001.096
1	6/8/96	18	27	1.5	TM000000000001.096
5	6/8/96	18	29	1.6	TM000000000001.096
1C	6/8/96	17	27	1.6	TM000000000001.096
1	6/14/96	17	28	1.6	TM000000000001.096
5	6/14/96	16	104	6.5	TM000000000001.096
1C	6/14/96	17	26	1.5	TM000000000001.096
1	6/20/96	19	34	1.8	TM000000000001.096
5	6/20/96	19	37	1.9	TM000000000001.096
1C	6/20/96	19	33	1.7	TM000000000001.096
1	6/26/96	7	15	2.1	TM000000000001.096
1C	6/26/96	7	15	2.1	TM000000000001.096
1	7/2/96	15	25	1.7	TM000000000001.097
5	7/2/96	15	23	1.5	TM000000000001.097
1C	7/2/96	17	24	1.4	TM000000000001.097
1	7/8/96	15	28	1.9	TM000000000001.097
5	7/8/96	15	30	2.0	TM000000000001.097
1C	7/8/96	16	26	1.6	TM000000000001.097
1	7/14/96	10	23	2.3	TM000000000001.097
5	7/14/96	10	24	2.4	TM000000000001.097
1C	7/14/96	10	22	2.2	TM000000000001.097
1	7/20/96	10	21	2.1	TM000000000001.097
5	7/20/96	9	19	2.1	TM000000000001.097
1C	7/20/96	10	22	2.2	TM000000000001.097
1	7/26/96	60	147	2.5	TM000000000001.097
5	7/26/96	57	148	2.6	TM000000000001.097
1	8/1/96	11	21	1.9	TM000000000001.097
5	8/1/96	11	22	2.0	TM000000000001.097
1C	8/1/96	11	20	1.8	TM000000000001.097
5	8/7/96	13	24	1.8	TM000000000001.097

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	8/7/96	14	25	1.8	TM000000000001.097
1	8/13/96	12	28	2.3	TM000000000001.097
5	8/13/96	13	26	2.0	TM000000000001.097
1C	8/13/96	12	27	2.3	TM000000000001.097
1	8/19/96	21	35	1.7	TM000000000001.097
5	8/19/96	21	34	1.6	TM000000000001.097
1C	8/19/96	22	34	1.5	TM000000000001.097
1	8/25/96	13	26	2.0	TM000000000001.097
5	8/25/96	13	29	2.2	TM000000000001.097
1C	8/25/96	14	26	1.9	TM000000000001.097
1	8/31/96	15	23	1.5	TM000000000001.097
1C	8/31/96	14	22	1.6	TM000000000001.097
1	9/6/96	10	20	2.0	TM000000000001.097
5	9/6/96	9	18	2.0	TM000000000001.097
1	9/12/96	9	24	2.7	TM000000000001.097
5	9/12/96	9	24	2.7	TM000000000001.097
1C	9/12/96	10	23	2.3	TM000000000001.097
1	9/18/96	6	18	3.0	TM000000000001.097
5	9/18/96	3	10	3.3	TM000000000001.097
1C	9/18/96	6	17	2.8	TM000000000001.097
1	9/24/96	9	17	1.9	TM000000000001.097
5	9/24/96	10	19	1.9	TM000000000001.097
1C	9/24/96	10	18	1.8	TM000000000001.097
1	9/30/96	10	20	2.0	TM000000000001.097
5	9/30/96	7	16	2.3	TM000000000001.097
1C	9/30/96	10	20	2.0	TM000000000001.097
5	10/6/96	8	14	1.8	TM000000000001.098
1C	10/6/96	7	14	2.0	TM000000000001.098
5	10/12/96	8	16	2.0	TM000000000001.098
1C	10/12/96	7	14	2.0	TM000000000001.098
5	10/18/96	13	31	2.4	TM000000000001.098
1C	10/18/96	11	26	2.4	TM000000000001.098
1	10/24/96	9	27	3.0	TM000000000001.098
5	10/24/96	7	48	6.9	TM000000000001.098
1C	10/24/96	8	25	3.1	TM000000000001.098
1	10/30/96	5	13	2.6	TM000000000001.098
5	10/30/96	5	14	2.8	TM000000000001.098
1	11/5/96	8	13	1.6	TM000000000001.098
5	11/5/96	7	14	2.0	TM000000000001.098
1C	11/5/96	8	12	1.5	TM000000000001.098
1	11/11/96	3	10	3.3	TM000000000001.098
5	11/11/96	4	9	2.3	TM000000000001.098
1C	11/11/96	4	8	2.0	TM000000000001.098
1	11/17/96	8	22	2.8	TM000000000001.098
5	11/17/96	7	21	3.0	TM000000000001.098
1C	11/17/96	8	21	2.6	TM000000000001.098
5	11/23/96	3	5	1.7	TM000000000001.098
1	11/26/96	6	20	3.3	TM000000000001.098
1C	11/26/96	6	20	3.3	TM000000000001.098
1	11/29/96	6	16	2.7	TM000000000001.098

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
5	11/29/96	4	13	3.3	TM000000000001.098
1C	11/29/96	6	16	2.7	TM000000000001.098
1	12/5/96	10	33	3.3	TM000000000001.098
5	12/5/96	6	22	3.7	TM000000000001.098
1C	12/5/96	10	31	3.1	TM000000000001.098
1	12/11/96	2	6	3.0	TM000000000001.098
5	12/11/96	2	8	4.0	TM000000000001.098
1C	12/11/96	2	4	2.0	TM000000000001.098
1	12/17/96	6	21	3.5	TM000000000001.098
5	12/17/96	2	7	3.5	TM000000000001.098
1C	12/17/96	5	17	3.4	TM000000000001.098
1	12/23/96	5	29	5.8	TM000000000001.098
5	12/23/96	4	25	6.3	TM000000000001.098
1C	12/23/96	5	27	5.4	TM000000000001.098
1	12/29/96	3	11	3.7	TM000000000001.098
5	12/29/96	3	8	2.7	TM000000000001.098
1C	12/29/96	3	7	2.3	TM000000000001.098
1	1/4/97	4	14	3.5	TM000000000001.099
5	1/4/97	2	7	3.5	TM000000000001.099
1C	1/4/97	4	14	3.5	TM000000000001.099
1	1/10/97	8	23	2.9	TM000000000001.099
5	1/10/97	5	15	3.0	TM000000000001.099
1C	1/10/97	8	22	2.8	TM000000000001.099
1	1/16/97	4	10	2.5	TM000000000001.099
1C	1/16/97	4	8	2.0	TM000000000001.099
1	1/22/97	4	7	1.8	TM000000000001.099
1C	1/22/97	4	7	1.8	TM000000000001.099
5	1/25/97	4	11	2.8	TM000000000001.099
1	1/28/97	5	11	2.2	TM000000000001.099
5	1/28/97	6	17	2.8	TM000000000001.099
1C	1/28/97	5	11	2.2	TM000000000001.099
1	2/3/97	4	15	3.8	TM000000000001.099
5	2/3/97	2	11	5.5	TM000000000001.099
1C	2/3/97	4	14	3.5	TM000000000001.099
1	2/9/97	3	6	2.0	TM000000000001.099
5	2/9/97	3	9	3.0	TM000000000001.099
1C	2/9/97	3	5	1.7	TM000000000001.099
1	2/15/97	2	6	3.0	TM000000000001.099
5	2/15/97	4	11	2.8	TM000000000001.099
1C	2/15/97	2	6	3.0	TM000000000001.099
1	2/21/97	2	12	6.0	TM000000000001.099
5	2/21/97	2	10	5.0	TM000000000001.099
1C	2/21/97	2	11	5.5	TM000000000001.099
1	2/27/97	8	18	2.3	TM000000000001.099
5	2/27/97	8	20	2.5	TM000000000001.099
1C	2/27/97	8	18	2.3	TM000000000001.099
1	3/5/97	4	9	2.3	TM000000000001.099
5	3/5/97	3	14	4.7	TM000000000001.099
1C	3/5/97	3	12	4.0	TM000000000001.099
1	3/11/97	10	22	2.2	TM000000000001.099
5	3/11/97	11	18	1.6	TM000000000001.099
1C	3/11/97	11	22	2.0	TM000000000001.099
1	3/17/97	10	18	1.8	TM000000000001.099
5	3/17/97	8	20	2.5	TM000000000001.099
1C	3/17/97	8	19	2.4	TM000000000001.099
1	3/23/97	11	24	2.2	TM000000000001.099
5	3/23/97	11	21	1.9	TM000000000001.099
1C	3/23/97	11	23	2.1	TM000000000001.099
1	3/29/97	6	14	2.3	TM000000000001.099
5	3/29/97	6	16	2.7	TM000000000001.099
1C	3/29/97	5	15	3.0	TM000000000001.099
1	4/4/97	9	22	2.4	TM000000000001.105
5	4/4/97	11	43	3.9	TM000000000001.105
1C	4/4/97	9	21	2.3	TM000000000001.105
1	4/10/97	6	16	2.7	TM000000000001.105
5	4/10/97	5	18	3.6	TM000000000001.105
1C	4/10/97	7	16	2.3	TM000000000001.105
1	4/16/97	11	21	1.9	TM000000000001.105
5	4/16/97	11	23	2.1	TM000000000001.105
1C	4/16/97	12	22	1.8	TM000000000001.105
1	4/22/97	11	23	2.1	TM000000000001.105
5	4/22/97	12	40	3.3	TM000000000001.105
1C	4/22/97	11	21	1.9	TM000000000001.105
1	4/28/97	14	30	2.1	TM000000000001.105
5	4/28/97	16	41	2.6	TM000000000001.105
1C	4/28/97	14	30	2.1	TM000000000001.105
1	5/4/97	9	17	1.9	TM000000000001.105
5	5/4/97	7	24	3.4	TM000000000001.105
1C	5/4/97	8	17	2.1	TM000000000001.105
1	5/10/97	12	33	2.8	TM000000000001.105
5	5/10/97	13	31	2.4	TM000000000001.105
1C	5/10/97	13	31	2.4	TM000000000001.105
1	5/16/97	14	31	2.2	TM000000000001.105
5	5/16/97	13	30	2.3	TM000000000001.105
1C	5/16/97	15	31	2.1	TM000000000001.105
1	5/22/97	17	34	2.0	TM000000000001.105
5	5/22/97	19	36	1.9	TM000000000001.105
1	5/28/97	12	28	2.3	TM000000000001.105
5	5/28/97	10	21	2.1	TM000000000001.105
1C	5/28/97	13	25	1.9	TM000000000001.105
1	6/3/97	19	36	1.9	TM000000000001.105
5	6/3/97	19	37	1.9	TM000000000001.105
1C	6/3/97	18	35	1.9	TM000000000001.105
1	6/9/97	16	33	2.1	TM000000000001.105
5	6/9/97	14	33	2.4	TM000000000001.105
1C	6/9/97	14	32	2.3	TM000000000001.105
1	6/15/97	4	12	3.0	TM000000000001.105
5	6/15/97	3	9	3.0	TM000000000001.105
1C	6/15/97	3	9	3.0	TM000000000001.105
1	6/21/97	18	35	1.9	TM000000000001.105

Table E-1. Continued.

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
5	6/21/97	16	41	2.6	TM000000000001.105
1C	6/21/97	18	34	1.9	TM000000000001.105
1	6/27/97	19	38	2.0	TM000000000001.105
1C	6/27/97	20	37	1.9	TM000000000001.105
1	7/3/97	9	20	2.2	TM000000000001.108
5	7/3/97	8	19	2.4	TM000000000001.108
1C	7/3/97	7	19	2.7	TM000000000001.108
1	7/9/97	10	19	1.9	TM000000000001.108
5	7/9/97	9	18	2.0	TM000000000001.108
1C	7/9/97	10	17	1.7	TM000000000001.108
1	7/15/97	21	41	2.0	TM000000000001.108
5	7/15/97	13	21	1.6	TM000000000001.108
1C	7/15/97	21	36	1.7	TM000000000001.108
5	7/21/97	16	34	2.1	TM000000000001.108
1	7/27/97	10	23	2.3	TM000000000001.108
5	7/27/97	10	23	2.3	TM000000000001.108
1C	7/27/97	11	22	2.0	TM000000000001.108
1	8/2/97	9	18	2.0	TM000000000001.108
5	8/2/97	8	15	1.9	TM000000000001.108
1C	8/2/97	10	16	1.6	TM000000000001.108
1	8/8/97	31	78	2.5	TM000000000001.108
5	8/8/97	26	57	2.2	TM000000000001.108
1C	8/8/97	34	76	2.2	TM000000000001.108
1	8/14/97	12	25	2.1	TM000000000001.108
5	8/14/97	12	21	1.8	TM000000000001.108
1C	8/14/97	12	23	1.9	TM000000000001.108
1	8/20/97	13	24	1.8	TM000000000001.108
5	8/20/97	10	17	1.7	TM000000000001.108
1	8/26/97	11	26	2.4	TM000000000001.108
5	8/26/97	9	16	1.8	TM000000000001.108
1C	8/26/97	13	26	2.0	TM000000000001.108
1	9/1/97	14	29	2.1	TM000000000001.108
5	9/1/97	14	28	2.0	TM000000000001.108
1C	9/1/97	14	28	2.0	TM000000000001.108
1	9/7/97	12	19	1.6	TM000000000001.108
5	9/7/97	12	18	1.5	TM000000000001.108
1C	9/7/97	12	19	1.6	TM000000000001.108
1	9/13/97	11	25	2.3	TM000000000001.108
5	9/13/97	10	23	2.3	TM000000000001.108
1C	9/13/97	10	24	2.4	TM000000000001.108
1	9/19/97	13	31	2.4	TM000000000001.108
5	9/19/97	13	29	2.2	TM000000000001.108
1C	9/19/97	14	30	2.1	TM000000000001.108
1	9/25/97	8	18	2.3	TM000000000001.108
5	9/25/97	8	17	2.1	TM000000000001.108
1C	9/25/97	8	21	2.6	TM000000000001.108
1	10/1/97	8	19	2.4	MO98PSDALOG111.000
5	10/1/97	9	14	1.6	MO98PSDALOG111.000
1C	10/1/97	12	20	1.7	MO98PSDALOG111.000
1	10/7/97	21	50	2.4	MO98PSDALOG111.000

Site	Date	PM_{10}[a]	TSP[a]	Ratio[b]	DTN[c]
1C	10/7/97	21	50	2.4	MO98PSDALOG111.000
1	10/13/97	3	18	6.0	MO98PSDALOG111.000
1C	10/13/97	4	17	4.3	MO98PSDALOG111.000
1	10/19/97	10	22	2.2	MO98PSDALOG111.000
5	10/19/97	10	17	1.7	MO98PSDALOG111.000
1C	10/19/97	11	21	1.9	MO98PSDALOG111.000
1	10/25/97	3	11	3.7	MO98PSDALOG111.000
5	10/25/97	3	9	3.0	MO98PSDALOG111.000
1C	10/25/97	4	10	2.5	MO98PSDALOG111.000
1	10/31/97	6	15	2.5	MO98PSDALOG111.000
5	10/31/97	4	9	2.3	MO98PSDALOG111.000
1C	10/31/97	5	13	2.6	MO98PSDALOG111.000
1	11/6/97	11	31	2.8	MO98PSDALOG111.000
5	11/6/97	5	11	2.2	MO98PSDALOG111.000
1C	11/6/97	12	30	2.5	MO98PSDALOG111.000
1	11/12/97	5	12	2.4	MO98PSDALOG111.000
5	11/12/97	5	8	1.6	MO98PSDALOG111.000
1C	11/12/97	5	12	2.4	MO98PSDALOG111.000
1	11/18/97	5	12	2.4	MO98PSDALOG111.000
1C	11/18/97	4	9	2.3	MO98PSDALOG111.000
1	11/24/97	10	29	2.9	MO98PSDALOG111.000
5	11/24/97	5	9	1.8	MO98PSDALOG111.000
1C	11/24/97	10	28	2.8	MO98PSDALOG111.000
1	11/30/97	3	7	2.3	MO98PSDALOG111.000
5	11/30/97	3	7	2.3	MO98PSDALOG111.000
1C	11/30/97	3	7	2.3	MO98PSDALOG111.000
1	12/6/97	2	6	3.0	MO98PSDALOG111.000
5	12/6/97	3	5	1.7	MO98PSDALOG111.000
1C	12/6/97	2	6	3.0	MO98PSDALOG111.000
1	12/12/97	1	5	5.0	MO98PSDALOG111.000
5	12/12/97	1	5	5.0	MO98PSDALOG111.000
1C	12/12/97	1	5	5.0	MO98PSDALOG111.000
1	12/18/97	4	12	3.0	MO98PSDALOG111.000
5	12/18/97	3	10	3.3	MO98PSDALOG111.000
1C	12/18/97	4	13	3.3	MO98PSDALOG111.000
1	12/24/97	2	6	3.0	MO98PSDALOG111.000
5	12/24/97	1	7	7.0	MO98PSDALOG111.000
1C	12/24/97	1	5	5.0	MO98PSDALOG111.000
1	12/30/97	4	10	2.5	MO98PSDALOG111.000
5	12/30/97	8	17	2.1	MO98PSDALOG111.000
1C	12/30/97	4	10	2.5	MO98PSDALOG111.000

Notes:

[a] $\mu g/m^3$

[b] TSP $\div$ PM_{10}

[c] No TSP measurements were collected from October through December 1991 (TM000000000001.043).